SCIENTIFIC AMERICAN

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TECHNOLOGY COPY

TAGGING THE SUBMARINE CABLE: AN INCIDENT IN THE LAYING AND REPAIRING OF OCEAN CABLES.—(See page 90)

Scientific American Publishing Co., Munn & Co., New York

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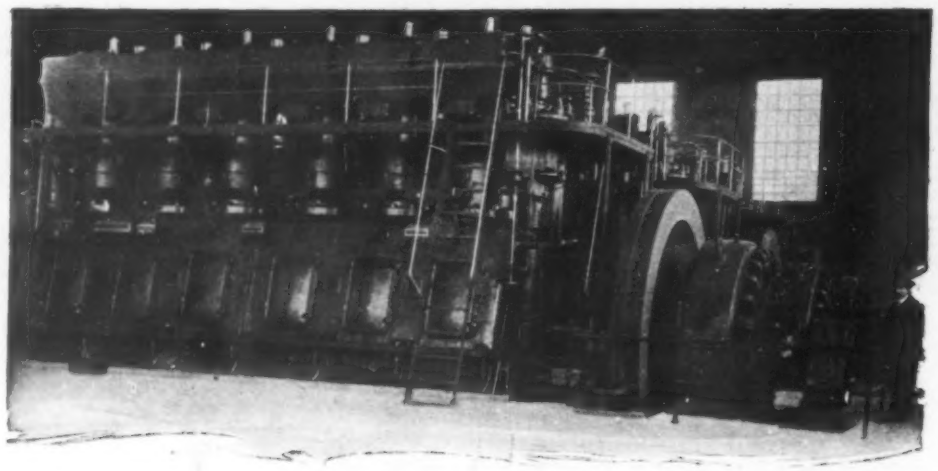

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THE SCIENTIFIC AMERICAN, August, 1922. Volume 127, Number 2. Published monthly by Scientific American Publishing Company at 233 Broadway, New York, N. Y. Subscription price, $4.00 per year. Entered as second-class matter June 18, 1879, at the post office at New York, N. Y., under the act of March 3, 1879.

With the Editors

WE have with us in this issue a most distinguished array of names which stand for leadership in their respective fields. Thus Secretary Hoover, of the Department of Commerce, addresses us on the subject of the new radio legislation, which is soon to go into effect and untangle the present radio traffic tangle due to the overnight development of radiophone broadcasting. General Pershing gives us his views on our National military policy, in an article which, because of the recent action of Congress to reduce our Army to a point where it becomes necessary to formulate anew the aims and policies of our national defense establishment, as outlined in General Pershing's contribution, is most timely. Guided and unguided communication is the subject selected by General Squier, Chief Signal Officer of the United States Army. Time was when there were two distinct kinds of communication—namely, wired communication and wireless communication; and these two kinds were held to be bitter rivals, with all that entails. Today, by a paradoxical development, both kinds of communication are one. The radio telephone works hand in hand with the wire telephone; the radio telegraph works hand in hand with the wire telegraph. Remarkable strides in wired wireless have indicated that wireless has just as much a place in our wire communication as in space or ether. All communication today is being unified, and instead of wire and wireless communication, we are coming to the terms "guided" and "unguided" communication, indicating whether the signals or speech are directed along a definite path, or broadcasted into the ether over a wide range. Somewhat along the same lines but dealing with a different and perhaps more romantic phase of communication, is the article by Lieut.-Colonel Chandler of the United States Army, retired. This officer's name has long been identified with the activities of our Signal Corps and he writes on his favorite subject, submarine cables. Another retired Army officer who writes in this issue is Edward C. Crossman, who is an authority on rifle shooting and small arms. Indeed, Captain Crossman, through his extensive writings, research work, and instructive activities while serving in our Army, has been largely instrumental in bringing our rifles and our rifle shooting to the present high state of efficiency. He writes on the development of accurate ammunition, which is the prime factor at the bottom of our remarkable rifle scores. Dr. Whitney, Director of the General Electric Research Laboratory, writes on the international character of successful research. Dr. Russell, America's foremost astronomer, contributes his usual monthly installment on astronomy, which have featured our pages for so many years.

PERHAPS no other journal is as often misquoted as the SCIENTIFIC AMERICAN. Whether it is due to the fact that our name is a household one, or again that it carries an enviable degree of authenticity, we do not profess to know. But the fact remains that large and small newspapers are forever attaching our name to scientific and near-scientific articles—much to our dismay or amusement. Thus in our daily mail we receive letters from the readers of the Bungville *Clarion*—the actual name does not matter—stating that in one of our issues we have an article on how to overcome baldness by the compounding of a few household staples. From India we receive a letter stating that the writer, a Hindoo student, wishes to compete for the $50,000 prize for the best essay on Voodooism or some indefinite something, far removed from our editorial scope. The amounts offered run into the tens of thousands of dollars, in some cases into goodly fractions of a million; but then what difference do a few ciphers make one way or the other! On the other hand, we are being correctly quoted by hundreds of newspapers and numerous periodicals day after day and week after week. Surely it is not difficult to determine at a glance whether we are being quoted or misquoted, the purported facts speaking for themselves.

VACATION time is now in full swing, and even the editors—real human beings deep down—turn a goodly fraction of their thoughts to the lighter side of life. One of our number will wait for his vacation until the cold weather, in order to sojourn down in Bermuda. Another is going abroad. Still another is taking a motor trip through many States on a real journey of adventure. The fourth member of the group is going to stay away from the office as many days at a time as possible, for his is the task of attending to the thousand-and-one details of editorial routine. But each and every editor is taking a vacation in name and appearance rather than in fact; for there is no other line of work in which the individual is closer to his work than editing. He becomes a part of the periodical or newspaper which he edits or helps to edit, and at no time during his editorial incumbency is he totally divorced from his duties. So, while we may be away from our desks and amid new surroundings, we are ever thinking of the SCIENTIFIC AMERICAN and watching for new ideas, relating the incidents of our daily lives to the needs and uses of the paper, and soliciting helpful opinions from all those we meet.

ARRANGEMENTS have been consummated whereby the following radiophone broadcasting stations are to send out SCIENTIFIC AMERICAN broadcasted talks regularly: WAH, Midland Refining Company, El Dorado, Kans.; WKL, Hamilton Manufacturing Company, Indianapolis, Ind.; WHK, The Radiovox Company, Cleveland, Ohio; KFZ, The Doerr Mitchell Electric Company, Spokane, Wash.; KNJ, The Roswell Public Service Company, Roswell, N. M.; WWL, Loyola University, New Orleans, La.; WKY, Oklahoma Radio Shop, Oklahoma City, Okla.; KOB, State College of New Mexico; WGR, Federal Telephone & Telegraph Company, Buffalo, N. Y.; WHO, West Virginia University, Morgantown, W. Va.; WBZ, Westinghouse Electric & Manufacturing Company, Springfield, Mass.; WMB, Auburn Electrical Company, Auburn, Me.; WKC, Jos. M. Zamoiski Company, Baltimore, Md.; WEB, The Benwood Company, St. Louis, Mo.; WGF, The Des Moines *Register*, Iowa; WSY, Alabama Power Company, Birmingham, Ala.; WWJ, Detroit *News*, Detroit, Mich., and others to be announced later. The WJZ Radio Corporation-Westinghouse radio-phone station at Newark, N. J., broadcasts the SCIENTIFIC AMERICAN address once a week as a feature of their Literary Evening. If you own a radio receiving set, do not fail to tune in on our talks, which are intended to supplement in a chatty sort of way what we do in greater detail and much more seriously by the written word.

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SEVENTY-EIGHTH YEAR

SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, AUGUST, 1922

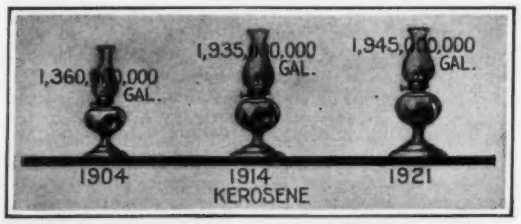
Where the Oil Goes

IN the early days of the petroleum industry the chief product was kerosene—the familiar "coal oil," as it was called, apparently in recognition of its use rather than in misunderstanding of its origin. The refining process was conducted with a view to the maximum yield of kerosene and the minimum of fractions too light or too heavy for inclusion in this classification. The quantity of kerosene required to light the lamps of America and of such foreign customers as might be developed was the factor that determined the amount of petroleum refined. This condition has within the past two decades been reversed, however, and today it is the number of automotive vehicles in use, and their requirements for gasoline—once a mere by-product of little value and less consequence—that governs the amount of petroleum refined, the manner in which this is split up into its fractions, and the constant search for fresh sources of supply.

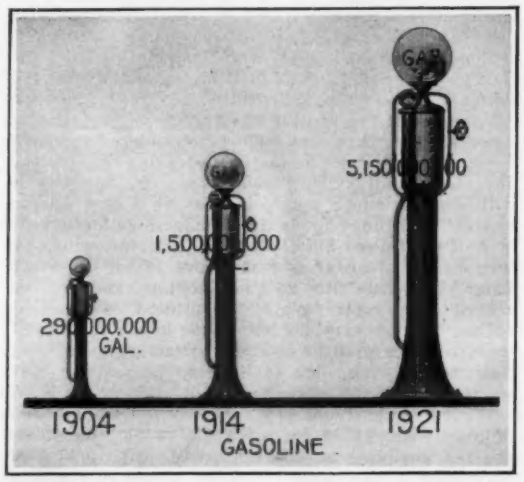
The central drawings below, showing the petroleum barrel split up into sections representing each major division of the refiner's trade, indicates the degree to which the center of gravity of this industry has been shifted. The kerosene which in 1904 constituted practically 60 per cent of the output is now less than one-eighth of the total. In 1904, when the automobile was just coming into its own, and the refiner was just learning that gasoline had a new and more important significance than that which had been attached to it as a mere chemical and cleaning fluid, the automobile-juice represented an eighth of the refiner's business; today it is between a quarter and a third and we are worried because we cannot make it more. At the same time the heavy fuel-oil which shares the internal-combustion field with gasoline and competes with coal in the raising of steam has leaped from 16 to 55 per cent of the refiner's total; while lubricants have fallen from 14 to 5 per cent.

These relative figures show as nothing else can show, just what has happened inside the refining industry. They do not, however, tell the whole story of the sheer expansion of this industry. This is to be visualized in the five smaller groups arranged about the page. If we look first at the lower left, we may note that the industry as a whole has expanded from a figure of approximately five billion gallons of crude oil in 1904 to one almost exactly four times as great for 1922. This expansion makes it possible for some of the other groups to surprise us. Thus, kerosene, which has suffered such an eclipse, has none the less increased in sheer bulk, being manufactured today to a volume duplicating that of 1914, and exceeding by about half that of 1904. And the lubricants which are today a mere 5 per cent of the total against 14 per cent at the beginning of the century, are able to show in the face of this fact a net increase of over half a billion gallons.

The production of lubricants has increased nearly three-fold during the seventeen years that have witnessed the development of the automobile



Kerosene increased until 1914, but since then has remained stationary so far as actual production is concerned, the growth of the petroleum industry as a whole having left it far behind



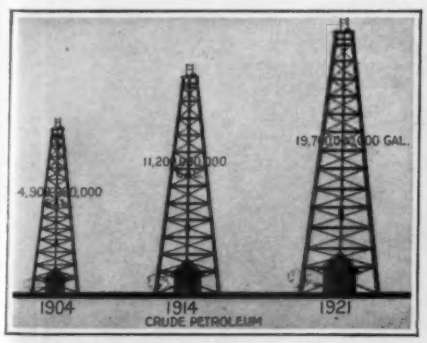
The big jump in gasoline production since the infancy of the automobile is here shown graphically

When we turn to gasoline and fuel oil we find both factors of comparison working in the same direction. Gasoline has multiplied its importance in the industry by 2½ and the industry itself has been multiplied by 4; and the net result is that we make about 18 times as much gasoline as we did. Fuel oil, paying more than a triple role in the industry today as compared with that of 1904, has multiplied its absolute production by about 30. The smaller figures which show the production of lubricants, kerosene, gasoline and fuel-oil, by actual gallons, are drawn so that the actual volume of the oil can, the lamp, the pump and the tank is in each case proportional to the figures represented; this relation is worked out independently for each group, however, and there is no relation at all, for instance, between the size of the oil cans and of the lamps. The mathematically inclined will recognize that the height and width and depth of the several cans, the several lamps, etc., stand in the ratio of the cube roots of the respective figures which they attempt to visualize. For the person of non-mathematical turn of mind we can do no better than point out that if a can, a tank, or anything else, is twice as high, twice as long and twice as broad as another one, the first contains, not merely twice; but eight times, as much as the second. Until the eye is educated to this fact these graphic comparisons are of course somewhat deceptive.

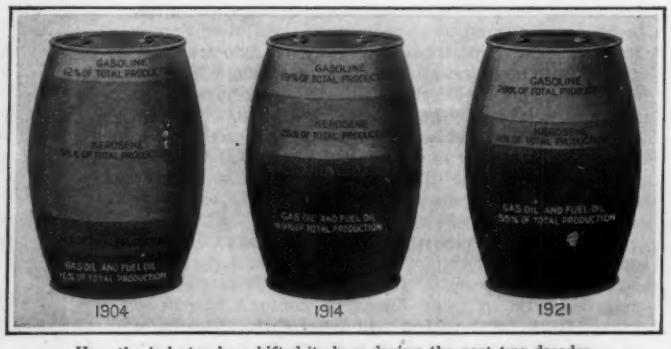
The barrels are split up into sections on a different basis. Each section is of approximately the same radius, etc.; so their respective contents are in the ratio of their heights alone. The true comparison is then got by making these heights proportional to the actual figures in the case, and not, as before, to the mere cube roots of these figures.

Specifications for Glass Tableware

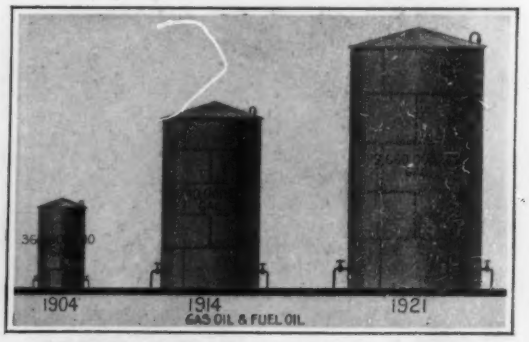
SOME time ago, the Bureau of Standards assisted in the preparation of specifications for glass tumblers to govern purchases of material of this kind for the Government departments. The success of any such specification depends entirely upon its ability to differentiate between satisfactory and unsatisfactory material. Recently the laboratory was able to apply the tests required in these specifications to samples for the entire line of glass tableware of one large retail dealer. The results obtained indicate that the tests are adequate to separate glass which will break too easily from glass of acceptable durability. However, additional evidence which is being accumulated will make possible the preparation of broader specifications.



The expansion of the petroleum industry as a whole

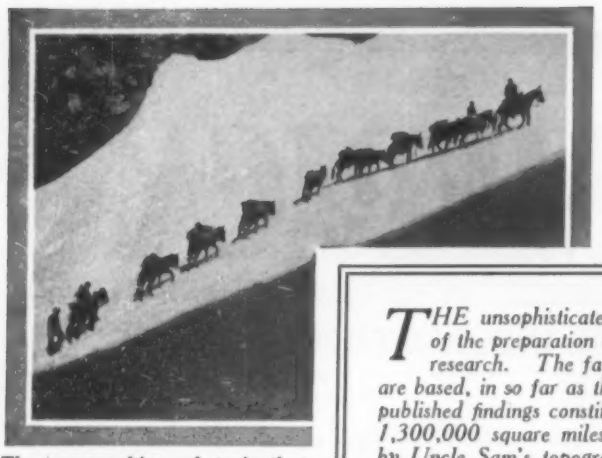


How the industry has shifted its base during the past two decades



Thirty times as much fuel oil today as 17 years ago

Further figures showing the production, in gallons, of the several major petroleum products; and the relative importance of each in the industry in 1904, 1914 and 1921



The topographic pack train that was necessary for the survey of the Mt. Goddard quadrangle, California

Our Strenuous Geological Survey—I

What It Means to Make a Topographic Map of the United States

By Guy Elliot Mitchell

United States Geological Survey

THE unsophisticated purchaser of a map or an atlas has, perhaps, a picture in his mind of the preparation of the map or maps in question by the publisher, as the result of original research. The fact is, most maps have a simpler history and a common source. They are based, in so far as this work is completed, on the survey by the Federal Government whose published findings constitute the output of the United States Geological Survey. No less than 1,300,000 square miles, constituting 43 per cent of our continental area, has been gone over by Uncle Sam's topographic surveyors. The maps which they have drawn, and which would have to be sold for many dollars if produced commercially, are available to all for a few cents each. The way they do their work, the things that they do, and the adventures which they have in doing them, constitute an absorbing story, and one with which Mr. Mitchell is thoroughly familiar. In this issue he has hardly space for more than an introduction, but even that, we believe, he makes interesting. In three future issues he will finish the tale.—THE EDITOR.

THE geographic exploration of the United States has by no means been completed. It was not long since, for instance, that Mt. Whitney in California was definitely determined to be our highest mountain. Previous to this several mountains had been heralded as the highest. Every year the exact elevations above sea level of hundreds of mountain peaks in various parts of the country are determined. The exact distances between various points are also established. New areas, of which no accurate maps are in existence, are mapped and their physical features put on paper as graphically as though miniature models were made of them.

Should you wander off the ordinary lanes of travel, especially in the West, you might chance to run across a couple of active, keen-eyed men headed for a dominant mountain peak, a thousand feet or so up from where you strike the trail. Let us get in close behind them and we will learn something about a part of the work of one of our most strenuous government field services. The hour is 7 o'clock in the morning. As we all stop for a moment to get our breath, there are pointed out far down in the valley two or three white specks, the tents of this surveying-exploring party. A little below two horses are tied to scraggly trees; they have brought the men as far as they could; the rest of the ascent must be by foot and by hanging on with tooth and nail. In something over an hour we reach the summit. The older of the two men spreads the legs of his tripod, screws the plane-table board on the top and takes two or three careful sights at distant points. "Here's where we are," he says, pointing to the intersection of a couple of lines that he has made on the partially completed map which is pinned down to his plane-table; "now a few more sights and I will tell you how many feet we are above sea level"—which are two quite interesting little accomplishments, when you come to think about them.

An excellent station for topographic mapping, if a somewhat dizzy one, in the mountains of Colorado

On all sides rise mountain peaks with ridges, gorges, gulches, and streams stretching away in the distance, and innumerable draws and gullies showing nearer at hand. The man takes sight after sight through his telescopic alidade, elevating and lowering it and swinging it from side to side, calling out numbers to his assistant, who jots them down in a book and quickly computes from a vertical-angle printed table the elevation above sea level of these points. With each reading the engineer makes a pin-prick on his map, indicating the location of his "shot." After a while the engineer stops his sighting and with a very hard pencil proceeds to connect these various points, drawing in contour lines which show every inequality of the surface of the ground. This is topographic mapping. If there are any roads, bridges, houses or other works of man, these too are placed in their exact positions. After a little while the engineer shoulders his instrument and moves on to another advantageous position and sights and sketches some more. In this way he will cover perhaps a square mile before it gets too dark to sight, and the result is the incomparable topographic map of the United States Geological Survey, which has been *completed* so far as that square mile is concerned. Later the pencil lines will be inked in, and then engraved on a copper plate and printed on enameled paper. But the map has been made in the field, and it is an exact miniature of that particular square mile. You can see everything on the map just as you could see it from the top of the mountain peak.

What I would emphasize is that the topographic maps of the Geological Survey are made on the ground and are not compiled at desks as most maps are made. Last year a good many of these keen-eyed engineers and their assistants were making maps in various parts of the United States—425 of them to be exact—and they covered 12,311 square miles of territory, making the grand total of the area mapped since the work began in 1879 equal to 43 per cent of the United States. Many of these maps, made 35 or 40 years ago, are somewhat crude and inadequate, failing to show the development and improvement of the country, and the areas will eventually have to be resurveyed. In order, however, that we get a proper perspective of the work, after accompanying our friendly engineer and watching him map his one square mile, it should be borne in mind that 43 per cent of the United States, exclusive of Alaska, is 1,301,136 square miles.

Let us see now just what are the contours of a topographic map, and then we will talk about some of the adventures of the engineers who sight their instruments and draw the contour lines. A contour line never varies from the level on which it starts. Beginning at some prominent point in a valley or a basin, say, for example, a thousand feet above sea level, the 1000-foot contour winds in and out around that valley through every point having the same level above the sea. The next higher line passes through every point 1010 feet above sea level (if the contour interval of the map is 10 feet), and the next line 1020 feet above the sea level, and so on, the meander of these lines showing every elevation from the lowest to the highest, and the shape of every hill and slope. Wherever the lines are close together it is evident that the slopes are steep, and where they are far apart the slopes are gentle. The contour interval may be any distance from 5 to 100 feet, according to the refinement of the map. These contour lines cover the map sheet. Every one of them is a level line indicating the elevation above sea level. A more detailed explanation of "What and Why Is a Contour," with pictures, will be found in the SCIENTIFIC AMERICAN of April, 1922.

In many places on the map the lines are broken by numbers showing the elevations. Thus you can find the 250- or the 200-foot level or the 13,220- or the 13,260-foot level according to the map, and everywhere that these respective contours run the elevation will be 250 or 13,260 feet above the sea as the case may be. Every topographic map thus becomes a wonderful hand dictionary of altitudes. You can determine not only the altitude of every town, crossroad or bridge, but that of every mountain peak, knoll or any part of their slope. You can trace and follow the fall of a river or creek. Place the point of your pencil at random on a map and a few seconds' inspection will give you the altitude of that point.

Add to this the representation of every work of man on the map in its exact location with reference to every other artificial and natural feature and you have in the topographer's map a miniature representation of the area itself. It is basic, a mother map, and its use for every class of engineering project is beyond value. All privately published maps—road maps, route maps, etc., etc., are based on the Geological Survey

Difficulties of a different sort are presented by the Hawaiian mountains with their "jungle" growth

productions, so far as these have been printed; and the careful student of such maps knows that where subsequent changes have made the Survey maps no longer accurate, the purchased map is ordinarily wrong, too. The railroad engineer need not run trial lines; he can spread out the map on his table and lay out his route. The irrigation engineer can pick out his reservoir sites; the contour lines will show him the location and capacity of his reservoirs and his tentative dam site. The farmer can plan his small drainage project. The geologist can plant on his map the ore deposits he is investigating or discovers. The hiker can lose himself in the mountains and then with his map as a guide reestablish his location.

Making a topographic map may be likened to building a house; first you select and lay out the site, next you plan and build the foundations to conform with the needs of the superstructure, finally erect and finish the structure to meet the requirements of pleasing appearance and practical utility. In making the map the first step is to determine exactly by astronomic observations certain geographic positions on the earth's surface—to establish the latitude by making observations on certain stars, and the longitude by measuring the observers' position east or west of some previously determined degree of longitude by means of telegraphic signals. True north is determined by observation of the North Star, from which true directions are established for all parts of the map. As a result of the astronomic work a brass tablet is usually set in a stone or concrete post, fixing exactly the location of the astronomic station and its description is published by the United States Geological Survey in a list of geographic positions in the United States.

The next step is to lay the foundation of the map by what is termed horizontal and vertical control, by triangulation through accurately measured lines. Points at many places over the whole area to be thus mapped are exactly located with reference to the geographic positions that were determined astronomically, and the completeness of this network of triangles depends upon the character of the map to be made. Triangulation is employed in the country that presents sufficient relief, but in level or heavily forested country traverse lines are run by the use of a transit. The vertical control consists of determining the exact altitude of points well scattered over the area to be mapped, by running level lines in circuits. These level lines are connected with other very exact lines which now cross the continent from ocean to ocean, so that the elevations established will refer to mean sea level as the datum plane, and will thus represent exact heights above the sea. At many points along such lines, permanent bench marks of concrete or iron are set, each bearing a properly marked brass tablet or cap giving the elevation of the surface at the point where it is set. Complete descriptions of these bench marks are published in bulletins of the Geological Survey, which, like the bulletins showing geographic positions, are available for public use and may be obtained on request.

These maps are published by the Geological Survey usually on the scale of almost exactly two miles to one inch, one mile to one inch or one mile to two inches. The maps are published in uniform-sized sheets, 16 inches by 20 inches. Their boundaries are parallels of latitude and meridans of longitude. The north and south or up- and down-distances of the mapped area of all 1:62,500 sheets, for example, is 36 miles, but as the areas approach the North Pole the quadrangles become narrower. At the Equator the quadrangle is an exact square.

On this scale of one inch to one mile, which is the one usually employed, the map of the United States would be about 3000 inches from east to west. It would cover about one acre. So accurate is the contouring that adjoining maps of the same scale if pasted together fit perfectly. These incomparable maps are sold by Uncle Sam at the nominal price of 10 cents each retail and 6 cents wholesale. A private concern would have to charge $5 to $10 each.

To map 43 per cent of the United States the topographic engineers are estimated to have tramped an aggregate of approximately nine million miles, for the average amount of walking varies from five miles for every square mile surveyed in ordinary country to ten or more miles in rough country.

New Literature for the Tourist

THE current season sees the publication, in addition to the various annuals with which the automobilist has been familiar for some years, of two new items which are of extreme interest. One of these is the Official Camping and Camp-Site Manual of the American Automobile Association. The other is the first four numbers of a brand new set of road maps, got out by the American manufacturers of the Michelin tire.

The camp-site manual recognizes the fact that some of us are confirmed campers, and that others are likely to attempt this sort of thing this year for the first time. For the tourist with no experience in camping a very sound outline of procedure and of equipment necessary is offered. For novice and expert alike, however, the greater value of the book will be found in the very complete list of camping sites which it contains.

It will of course be understood that no attempt can be made to list all the farmers and ranchers who are willing for automobilists to poach on their premises for a night, or of the unoccupied lands that are just naturally open for camping. What the book undertakes is rather a compilation of the places where camping is a recognized institution. Many of these places are organized camp grounds established and run by municipal authorities, automobile organizations, etc. A smaller number consists of places where running water is available and a fire-place has been built by previous campers or the owner. In all, somewhat over 900 camping places are listed. These are arranged by routes—Lincoln Highway, Colorado-to-Gulf Highway, etc.—or under geographic captions like "Adirondacks and Catskills;" and then they are carefully indexed by states and localities, so that in one way or another one cannot fail to find what one seeks. A summary of the fishing and hunting laws of the various states is included, with much other fine material. The book may be got of the Association, at its New York or Washington headquarters, for fifty cents.

The Michelin maps we take it will eventually cover all the country. The four now issued, the first of the series, are for adjacent sections of New England and the middle states, extending from about the latitude of Concord, N. H., to that of Dover, Del. An extremely clever scheme of folding and binding makes it possible to examine any part of the map whatever without unfolding it in the least, yet without the usual hiatus in passing from one page to another of a sectional map like those in the Blue Book. The experienced driver does not need to be told what a boon this is in consulting the maps while in the open.

These maps are in five colors. They give a vast deal more information about the road and what one may expect to find along it than the average road map. Indeed, in this respect they are the nearest approach to the Geological Survey sheets that we have seen; and they go beyond these in classifying the roads into trunk lines, good roads, and country roads. And while their indications of topography and possible scenery are not so complete as those of the survey maps, they are surprisingly full, and will be found by many users easier to read. The full possibilities of the five-color system have never been developed to greater advantage. The price of these maps is 75 cents per section, and they may be ordered from Milltown, N. J.

The Colloidal Theory of Rust

PROBABLY no subject has had more widespread discussion nor is more ancient a problem than that of rust, its cause and prevention. Of late there has been a new theory called the colloidal theory of rust, formulated by Dr. Newton Friend, an Englishman. He delivered an address on this subject before the Birmingham Metallurgical Society late in 1921, in which he examined various theories and then stated that his colloidal theory reasonably accounted for the facts of corrosion.

According to this lecturer, if moving water was increased to a velocity of eight miles per hour, no corrosion of immersed metal took place. According to the colloidal theory, corrosion of iron in a neutral solution of water was entirely distinct from corrosion in acid. Iron first passed into solution through the presence of electrolytes, gradually developing a solution of ferro hydroxide, which eventually produced oxidation. The solution, however, could be removed by rapidly flowing water, thus inhibiting corrosion. The same retardation could be effected if the colloid was coagulated either by physical or chemical precipitants.

Particulars were given of various experiments made to test the theory. Solutions containing alcohol reduced rust relatively to the increase in alcohol.

On the question of the effect of temperature on the rate of corrosion practically nothing was known. But experiments had shown that at 80 degrees Centigrade iron corrodes nearly ten times as rapidly as at 0 degree. The effect of light was very remarkable. Light was shown to accelerate corrosion very markedly, even after the temperature effects had been removed. Corrosion was clearly affected by barometric variation. The subject was very complex, and the results were not always the same, even when experiments were carried out under what appeared to be exactly identical conditions. The lecturer expressed the hope that further experiments would indicate the bearing of the colloidal theory upon the corrosion of ferrous alloys and non-ferrous metals.

Left: Topographic surveying in dense brush of the Sacramento Valley, Cal. *Center*: Geologist working on the crested Butte coal field, Col., where the hordes of mosquitoes render gloves and head-net a necessity. *Right*: Topographer and assistant, with tripod, note-book, plane table, alidade, and other equipment—including the very essential umbrella

In the field with Uncle Sam's topographers

Policing the Ether

Bringing About Order Out of Disorder Through the Radio Bill Now Before Congress

By Hon. Herbert Hoover
Secretary of Commerce

THE ether, or whatever may be the medium which carries the radio waves from the transmitter to the receiving set, must be policed. Ever since 1912 there have been in force certain laws and regulations, as well as a system of operators' and station licenses, for the use of the ether; and these laws and regulations and licensing systems served admirably until the advent of radio-phone broadcasting. Just as the rules of the road, such as they were, became hopelessly obsolete and inadequate when the automobile came into existence, so have the laws and regulations and licenses of 1912 become antequated and obsolete in the face of the radio-phone broadcasting activities throughout the nation. Then again, the automobile was not an overnight development: it required years of slow and painstaking progress before it became an important factor in our transportation scheme. The radio-phone, on the other hand, was developed into an everyday, nation-wide convenience overnight.

Hence the radio laws which were formulated when the radio telephone was little more than a laboratory experiment, have proved absolutely useless and even detrimental in the present radio traffic tangle. But the Government, represented by the Department of Commerce, in charge of radio regulations, has been quick to realize the inadequacy of the present radio laws, and has devoted no little time and effort, aided by the various groups interested in radio communication, toward the formulating of new and more suitable laws and regulations. And no one, to be sure, is better prepared to speak on the subject than Hon. Herbert Hoover, Secretary of Commerce, who addresses you through these columns.—THE EDITOR.

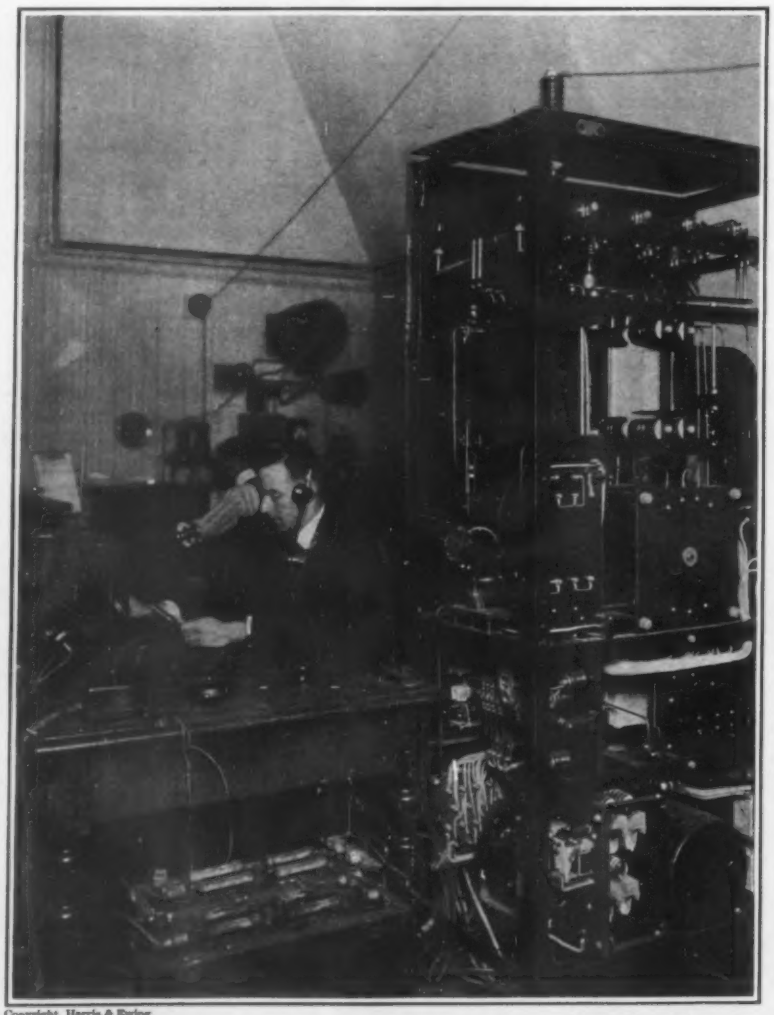
TO establish authority by which to provide order, instead of anarchy, in the ether, is the purpose of the Radio Bill now before Congress. The bill expresses the recommendations of the technical, amateur and legal committees of the Radio Conference called at the request of the President on February 27. It looks to procuring for the largest number the benefits to be derived from systematized use of the ether; establishes conclusively the legal right of the Bureau of Navigation to grant, and to revoke, operator and station licenses; provides for the collection of fees with which to maintain more adequately the work of inspection, promises a fairer and more orderly allocation of available wave bands, and, to make Federal regulation continuously effective, establishes an advisory committee composed of representatives of the departments and the public, to assist the Department of Commerce to provide, concurrently, without the delay attendant on new legislation, for unexpected changes in the science, and, notably, for developments in the use of the radio telephone.

Existing authority, which is clearly inadequate, is based on the act approved August 13, 1912, and on the International Convention of the same year, before the advent of the radio-phone, which for practical purposes was the product of the war and the years immediately following the war. Since 1912 the radio-phone, in the point of view of the public, has come to have larger importance even than the radio telegraph, yet the only reference to the phone in the original legislation is in Section 6: "The expression 'radio communication' as used in this act means any system of electrical communication by telegraphy or telephony without the aid of any wire connecting the points from and at which the radiograms, signals or other communications are sent or received." Moreover, while the use of the radio-phone has spread with incredible rapidity so that it is now estimated there are fully a million and one-half of radio-phone receiving sets in the United States, the use of wireless telegraphy has also greatly been extended. The resulting confusion has operated to discourage progress, temporarily, in a field which has already attracted a larger range of technical, as well as amateur, abilities, than any scientific development, heretofore.

The relation of the many stations owned by the various departments of the Government to private and commercial stations has also presented a perplexing problem. The military and naval branches of the Government in particular have contended vigorously and with justification that their stations ought not to be subjected to civilian control. Accordingly the bill for the first time differentiates between governmental and military, or naval, uses of radio. It provides that the President shall allocate wave lengths which Government stations shall use for strictly governmental purposes, while all other governmental broadcasting shall be subject to the same central regulation and control as is maintained for private transmitting stations.

The bill also amends the provision in the basic law to the effect that the wave lengths, 600 to 1600 meters, shall be reserved, in accordance with the International Convention, for military use. The conference was of the opinion that all wave lengths in this large range not essential to military use, should be made available to the public. Accordingly, the present Radio Bill proposes that this reservation be removed. In other words, when the Government's essential requirements will have been determined by the President, a much larger range for broadcasting will be available to the Department of Commerce for allocation to the best possible advantage.

Amateurs can then be encouraged in a larger way. Newspapers, more than forty of which are now broadcasting, can be afforded a separate band. Commercial broadcasting can be stabilized in a larger plan. Interference will be diminished. And the general result of the proposed legislation must, therefore, recommend itself to the industry and the public, generally.



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Radio-phone broadcasting station recently installed in the United States Post Office Department Building at Washington, D. C., for the broadcasting of Governmental bulletins and talks

The Moss Rose

THE origin of the moss rose is the subject of a paper by Major Hurst and Miss M. S. G. Breeze in the recent issue of the *Journal of the Royal Horticultural Society*. The moss rose differs from the cabbage rose only in the much greater development and branching character of the glands on petioles and sepals and the branching of the latter. The cabbage rose has been in cultivation for more than 2000 years, and the earliest record of the moss rose is from Carcassonne, in southern France, where it probably originated as a bud-mutation from the cabbage rose at least as early as 1696. The mossy character has since arisen independently from two other varieties of the cabbage rose.

Thus, in 1775 the Unique Rose appeared in a garden in the eastern counties as a tinged-white variety, and in turn gave rise to the "Unique Moss" through a bud-mutation in France about 1843. The Rose de Meaux is a miniature variety of the cabbage rose which may date from about 1637. A moss-mutation appeared from this in the west of England in 1801. Both the moss and cabbage rose are sterile, and there is little doubt that all these derivatives arose from the old cabbage rose as bud-mutations. The records show that at least seven bud-reversions from the moss rose to the cabbage rose occurred in the period between 1805 and 1873. In the half-century following 1788 seventeen varieties of the moss rose appeared, one of which was single and fertile and extensively used in crossing. Twelve of these bud-mutations are parallel to corresponding earlier variations in the old cabbage rose. Bud-mutation is therefore a frequent phenomenon in Rosa Centifolia under cultivation, and there is, as the authors suggest, a direct connection between this condition and the sterility. The evidence indicates that the mossy character is in all probability a simple Mendelian dominant.

Fire at Sea

Means of Minimizing an Ocean Peril of Increasing Prevalence

By Robert G. Skerrett

PROPERTY losses aggregating $14,656,355 were the toll levied by fire upon hulls and cargoes under United States Registry between 1911 and the end of the first half of 1920; and these figures do not include the sacrifices to flame among our shipping during the few years of our participation in the World War.

In an informative paper prepared by no less an authority than Sir Westcott S. Abell, read recently, which covers sea casualties and fatalities for the interval between 1890 and 1913, this expert said: "If the fire risks be taken as a percentage of the *total number of casualties*, it will be observed that they have risen from somewhere about 1.6 per cent at the beginning to about 6 per cent at the end of the period under review."

During the discussion of the foregoing paper, the following statement was made: "The increase of casualties due to fire is somewhat alarming, and the Board of Trade in their new Notice to Shipowners, Shipbuilders and Masters, have laid down some new recommendations. They call attention to the important fact that a fire, which in its initial stage might be quite easy to extinguish, might, if allowed to develop, become beyond control. The necessity of providing some ready and reliable means of fire detection would appear to be apparent, and it is perhaps fortunate that such appliances are now available." The purpose of this article is to describe one of these systems—one which has been installed on some scores of vessels and which has amply demonstrated its effectiveness. But before doing this, it might be well to outline the conditions that contribute to fires on shipboard. This can be done only in a general way.

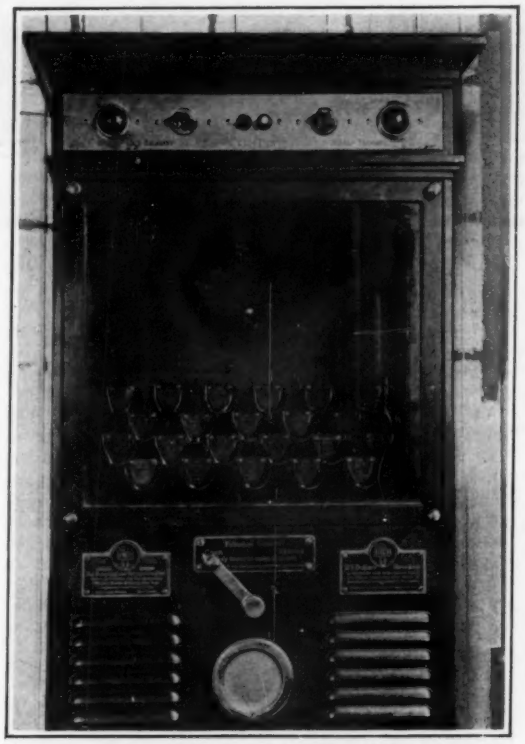
Fires are started by the heat engendered by friction between neighboring masses of cargo shifting in a seaway; by spontaneous combustion of parts of the cargo; by the generation of inflammable vapors; by the oxidation of bunker coal; by fuel oil; by the short circuiting of defective electrical wiring; by the heating of steam pipes; by carelessly handled or neglected oil lamps and torches; by dropped matches or the smoking of stevedores and members of the crew; by rats; by lightning; by cotton bales carrying smoldering fires hidden deep within them; and, in short, by various agencies, many of which are beyond human control.

A table showing the diversified nature of the origin of marine fires, reveals that quite 65 per cent of the fires originated below decks, and that of these fires fully 72 per cent occurred in the cargoes! In 1890, aboard British ships, spontaneous combustion was responsible for only 0.125 per cent of all the casualties to steam vessels, while by 1913 the losses from this cause had mounted to 1.5 per cent. Here, apparently, is a source of danger which is of a peculiarly insidious character, and, because of this and its increasing menace, the safety of the ship and her cargo, not to mention the security of the people aboard, rests upon the prompt detecting of a fire at an incipient stage.

While our shipping regulations require that all steamers of more than 150 feet in length shall be equipped with automatic fire-alarm systems throughout passenger staterooms or other sleeping quarters and in those parts of the ships which are not accessible to the observation of officers and crews, it is a curious fact that in practice no fire detecting system is demanded, by the constituted authorities, in the holds or inaccessible cargo spaces of either passenger or essentially freight-carrying craft. Accordingly, the very places where fires occur most frequently and where they are hardest to locate and to deal with are pretty generally unguarded, so that a conflagration there can gain considerable headway before repressive measures are applied.

The Rich system for detecting and extinguishing marine fires is designed to minimize the hazards due to an outburst of flames in cargo holds; and broadly stated, the system may be described as a supplementary feature of a protective measure already prescribed by law. To be specific: Congress, in 1905, added the following to the U. S. Revised Statutes: "Every steamer carrying passengers or freight shall be provided with suitable pipes and valves attached to the boiler to convey steam into the hold and to the different compartments thereof to extinguish fire." This is what is commonly known as the steam-quenching system; and steam, as has been repeatedly demonstrated, will suppress fire within confined spaces. But this arrangement, in itself, does not detect or locate the lurking peril, and for this reason the installation meets but one angle of the problem.

The system under review amplifies the service possibilities of the steam-quenching equipment, and, up to a point, uses the same piping to reveal at the earliest moment the presence of fire anywhere within the more or less closely packed holds. Not only that, but ingenious apparatus makes the menace visible where someone is always on watch, and, at the same time, indicates exactly where the fire threatens.



A cross-section of the fire-detecting cabinet showing the principal features and their interrelations

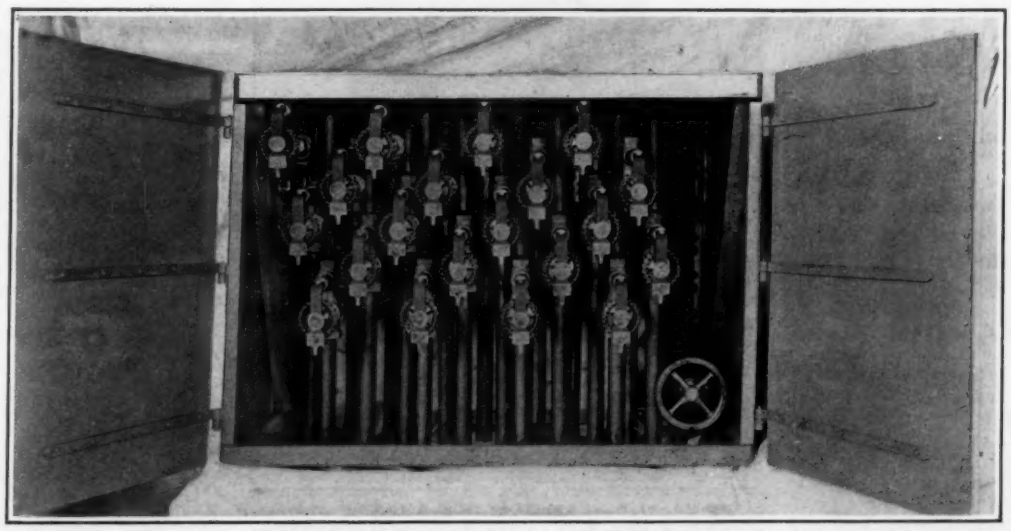
The vessel, as shown in our engraving, for the sake of economy of material and convenience in dealing with an emergency, is divided into two fire-control divisions—one forward and one aft of the engine and boiler spaces; and the 1½-inch piping of each division is brought to a focus at a control cabinet where every one of the 15 tubes ends in an ingenious three-way valve. From that cabinet, 15 separate ¾-inch flexible metal pipes—such as are used for electric-wire conduits—are led to a detecting cabinet placed in the steamer's chartroom. Thus 30 connections are made with the detecting cabinet in the pilot house, and each of the 30 tubes is linked with a funnel or flare carrying a distinguishing nameplate. By this arrangement all storerooms or cargo spaces have their several lines of communication with the detecting cabinet; and smoke issuing from one or more of the flares shows just where fire exists.

For the sake of greater clearness, let us suppose that the lower forward cargo space is the seat of trouble, and we will say that fire started there by reason of friction induced by the rolling and pitching of the vessel. Inside of five minutes from the ignition of the goods, smoke, entering the accumulators in the holds, will have traveled through the 1½-inch pipe up to the forward control cabinet, thence through the associate three-way valve, and from there on, by way of the three-quarter-inch connecting tube, to the detecting cabinet, whence it will issue from the right telltale flare. Immediately, the officer on duty will order the closing of the associate three-way valve in the control cabinet. This will serve to shut off the smoke pipe between the valve and the detecting cabinet and simultaneously turn steam into the 1½-inch pipe leading down and forward to the endangered compartment. Steam will be fed into this space long enough either to extinguish the fire or to hold it in check until port is reached.

After a suitable interval, the steam supply is shut off by restoring the valve to its normal position. This again opens up communication between the compartment and the detecting cabinet. If, then, dense smoke is emitted by the flare for any considerable period this is a sign that the fire is still alive and that steam must once more be discharged into the burning hold. On the other hand, if the smoke thins out rapidly this is an indication that the flames have been smothered. Should the conflagration break out afresh, warning of that fact will be given as before. It should be understood that in closing a detector tube in order to send steam into its associate compartment, this action does not affect the other warning circuits. Therefore, should the fire spread to neighboring holds, this condition will be speedily revealed by the discharge of smoke from the proper flares.

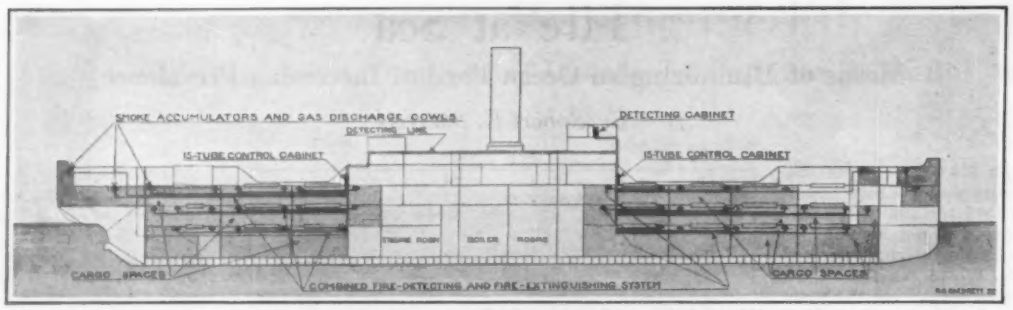
It might be well to mention here that there are many commodities that are transported in the holds of merchant steamers which would be ruined if exposed to steam. Therefore, this system makes provision for the substitution of a fire-choking gas, such, for instance, as carbonic acid gas, technically termed CO_2. This gas, in a liquid state, can be had in steel flasks having a capacity of about 100 pounds apiece. Such a quantity of liquified CO_2, when released, will expand and vaporize and produce a large volume of gas. Carbonic acid gas will not injure the most delicate textiles or damage foodstuffs exposed to it, but it will smother a fire more effectually than steam. All that is necessary is to connect the gas tanks to the fire-quenching mains and to close the latter from the boilers. The gas will be ready to perform its part the moment any one of the three-way valves is manipulated to fight a fire.

To fully realize just what the Rich system represents as a detecting agency, it is necessary to describe in some



The nested three-way valves inside a fire-control cabinet. The wheel at the lower right turns on either steam or inert gas after any one of the three-way valves has been manipulated to fight a fire

detail the get-up and the functioning of the cabinet in the pilothouse. To facilitate this understanding, one of our illustrations shows a vertical cross-section of this dominating element of the equipment. Beginning at the bottom of the drawing, we see an electric motor attached to a rotary blower. This fan induces a suction which tends to exhaust the airtight chamber within which are placed the numerous flares. As a result, there is an induced draft set up between the chamber and all of the compartments or holds linked with the system. Therefore, with the fan continually in operation, air is sucked from the several cargo spaces or storerooms; and the upward current at each flare is shown by the ceaseless waving of threads of silk placed in the mouths of these funnels.



The shaded areas represent cargo spaces and storerooms. The mushroom-like cowls have their openings covered with wire netting and serve a two-fold purpose of gathering in tell-tale smoke and of discharging either steam or an inert gas for the smothering of the flames

A longitudinal section of a large steamer equipped with the Rich fire-detecting and extinguishing system

Should smoke be generated in a freight space it will be drawn up through the connecting artery; and just before it is emitted from the flare it will be brought into the path of an upward projected and focused beam of light. This light, impinging upon the smoke particles, makes them vividly luminous; and the effect is intensified by the contrast of the black non-reflecting background of the top, the two sides, and the rear wall of the airtight chamber. The light projectors are grouped around two incandescent electric bulbs which burn all the while; and should either of these lights fail a buzzer sounds a break-down signal. It takes but a moment to replace a lamp. Ordinarily, no light is visible from the flares save that which may be caught by the waving threads of silk.

When the warning smoke, drawn from the airtight chamber, has reached the blower it is always discharged, in the first place, directly into the pilothouse or chartroom, so that the people there, if they have not noticed the luminous column in the cabinet, will be aroused to the danger by their sense of smell. Indeed, the generation of noxious or premonitory fumes by the cargo—indicating a serious rise in temperature—may be thus detected when the light projectors could not render the gases visible. It is only necessary to move a handle to direct the exhaust of the blower outside of the pilothouse. The cabinet is provided with two motors, and should one of them fail the other can be instantly brought into service. In case of a breakdown of a motor, the fact is announced by both a buzzer and two flashing red bull's-eyes. The motors of the exhausters, as the blowers are called, are designed to run continuously for periods of 16 months without oiling or attention of any sort. The light within the cabinet at the top of the airtight chamber may be turned on, if needful, to facilitate reading the nameplates on the flares.

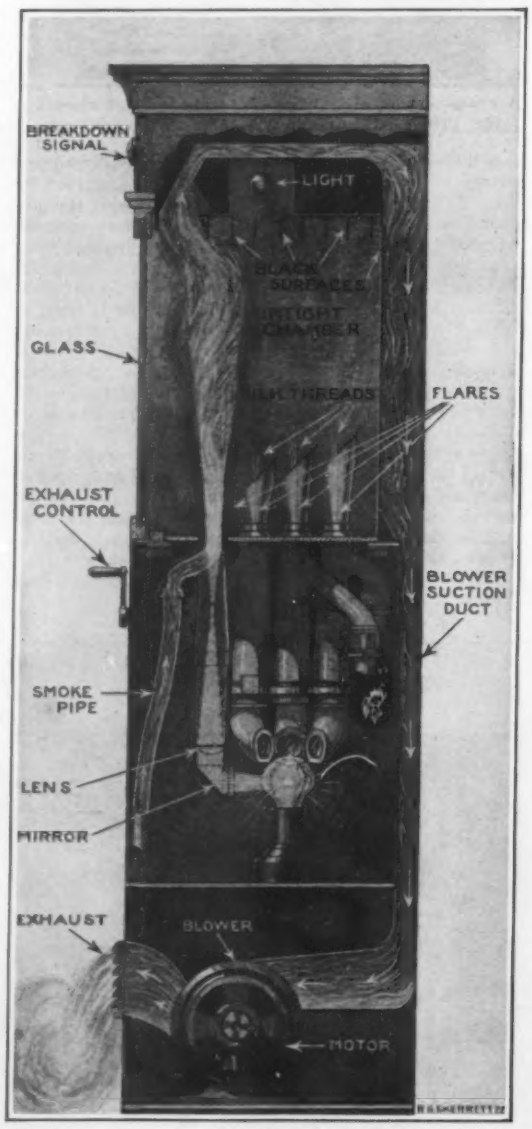
It should be mentioned that this system will continue to function without repair after fire has been detected; and in this respect the installation is decidedly unique. It has still another outstanding advantage: fire is indicated in the earlier stages of combustion, before there is any marked rise in temperature. In other devices, which depend upon the development of heat to make them effective, the fire must gain considerable headway before warning is sounded or otherwise made known.

This article might be considerably amplified if instances were cited where this equipment has done excellent work and nipped potential disasters in the bud. It is enough to say, however, that a number of vessels have undoubtedly been saved from total destruction by this system of timely fire detection, control, and suppression.

New Class of Dyes Permits Dyeing of Two Colors Simultaneously

THE art of dyeing is of ancient origin. The early Egyptians knew how to dye their fabrics all sorts of beautiful shades. Other ancient peoples as well were familiar with the art, and brightly colored fabrics were prized very highly. The famous Tyrian purple, the supreme dye, par excellence, of the ancient world, was sought after by kings and potentates and the extremely wealthy, and was literally worth its weight in gold. This dye was obtained from a mollusc, that is found even today along the shores of the Mediterranean, near where the ancient Phoenician cities of Tyre and Sidon once flourished and held maritime sway over the inland sea. Just one drop of the dye could be obtained from a mollusc, and to get sufficient dye to color a cloak or mantle, thousands of these creatures had to be gathered up. The first use of this dye is clothed in myth. The story runs that a dog, following two gods walking along the sea-shore, bit into one of these molluscs and to his surprise found his jaws covered with a blue foam, which could not be removed.

Not only did the ancients know how to dye, but they also knew that mordants, that is fixatives, had to be used with certain dyes to get them to stick to the fabric. They learnt further that by varying the mordants they could dye a piece of cloth two or more different shades. Since ancient times the development in the methods of dyeing has been not very startling. Almost all of dyeing processes today are ancient in origin. The dyes are to be sure modern, in that they are now made synthetically and not extracted as heretofore from vegetable and animal life, that is not on as large a scale as a generation or two ago.



Close-up view of part of the detecting cabinet. Note that each flare carries a distinguishing nameplate which corresponds to the compartment or hold with which it communicates

In England during the past few months a new development in dyeing has been perfected, which is novel and which it cannot be said was known to the ancients. This method is an outgrowth of the synthetic manufacture of dyes. It depends on the use of a new class of dyestuffs, made by building up complex compounds from simple beginnings. These new dyestuffs are known as the "ionamines." They come in various colors, such as yellow, orange, red, and in a considerable variety of shades of these colors. They will dye artificial silk only, that is the variety known as acetyl silk; but on natural silk, cotton and wool they are entirely without effect.

The dyes possess one very characteristic property which distinguishes them from all other dyestuffs and makes their application of considerable importance, fraught with great possibilities of future development. Many fabrics are made from cotton with silk threads interwoven so as to give "effect." The cloth from which men's shirts are made is a good example of such a textile. Generally in order to give the silk threads a different color from that of the cotton background, the threads are dyed before they are woven into the fabric. This is not an easy process to carry out. The new dyes will dye the silk only, and there is a class of dyes, known as the direct cotton dyes, which will dye cotton directly but which will have no effect at all on acetyl silk. So, when a bath of the dyes is made up to contain both varieties of dyestuffs, a selective action is secured on the fabric. For example, if chlorazol blue, a direct cotton dye, coloring cotton just by inserting the fabric in the dye bath, and a yellow ionamine are mixed together in one bath, and the cotton fabric, with acetyl silk threads running through it, is dipped into the dye, the result is that each dye will seek its particular fiber for which it has an affinity. The cotton will be dyed a pure blue and the silk a pure yellow. The colors do not run into each other, for they have no action on any other fiber except the one for which they have an affinity.

As there are many direct cotton dyes that will act in this manner, there are almost unlimited variations possible to this process. It is also possible to make various changes on the fiber after dyeing, which results in the development of a still greater variety of shades and simultaneously in materially increased fastness of the dyes.

New Bearing Metal of Unusual Properties

A NEW bearing metal, known as Ferrymetal, has come upon the market which is an alloy of lead, calcium, barium and small amounts of other constituents. It is claimed that rods and tubes can also be made of this alloy and that it is possible to roll sheets and to make complicated die castings without difficulty.

The production of this alloy by the usual method of smelting the metals as in previously made alloys entails high losses, as Ca and Ba are volatile. The alloy is therefore manufactured electrolytically by the electrolysis of molten Ba and Ca chlorides over an anode of molten lead. The lead is melted in a suitable container and covered with a layer of the chlorides, a graphite anode being then dipped in. The chlorides are melted by the current and the separated Ba and Ca pass into the lead. The process is a very lengthy one, as it takes three days to separate 2 per cent of Ba and Ca. When the alloy of the desired composition is obtained—dip samples being taken from time to time to ascertain this—the melt is poured into a large heated mixer in which other additions are made, usually 0.25 per cent mercury and very small amounts of other elements. The average composition of the alloy is 96.75 per cent lead, 2 per cent barium, 1 per cent calcium, 0.25 per cent mercury.

The melting point of the alloy is 445° C., and it is found to possess age-hardening properties, the Brinell hardness an hour after casting being 22.6, against 24.4 after seven days and 25.7 after twenty-eight days. Of special importance is the fact that the alloy is practically unoxidisable. In many respects its properties are similar to those of duralumin, but the test figures are somewhat lower. In comparison with other bearing metals, the loss of hardness at high temperatures up to 150° is small.

Our National Military Policy

An Organization Embodying the Views of Our Citizen Soldiers of the Late War

By General John J. Pershing

THE history of American wars is one of gallant deeds on the part of our officers and men, but it is also one of hasty and extemporized organization. This has always led to undue loss of life and heavy financial burdens.

Our success in our early wars was due more to the weakness of our enemies and to the fact that they had military engagements elsewhere than to wise preparations or superior training on the part of our own forces or leaders. We have always relied upon our traditional citizen army, but Congress heretofore has never provided for the organization of that citizen army in time of peace. In the Civil War the Union was saved in spite of our unpreparedness because the Confederacy also had to extemporize an army before it could take the field effectively. As to the World War, a substantial condition of preparedness known to all peoples might have prevented the war altogether. In any event we would have been in a position to bring it to an earlier termination.

Never until recently have we sought a remedy for this defect in our military institutions. After each war we had neglected to take any steps toward making our military experience available for the benefit of future generations. In the fall of 1919, however, a careful study of our entire military policy was begun by the Military Committees of Congress which resulted, for the first time in our history, in the adoption of a sound military policy, which is embodied in the Army Reorganization Act of June, 1920. The veterans of the World War exercised a powerful influence in the passage of this law. In its essential features it conforms to the recommendations of the American Legion's first convention at Minneapolis. It thus represents the view of our great body of citizen soldiers fresh from actual experience of war. It is very important that this policy be developed if we are not to drift hopelessly back into the pre-war condition of lethargy and inactivity.

In order to judge intelligently we should understand the full significance and possibilities of this important act of Congress. Most of our people have as yet a hazy idea of this subject. Those who merely read the law remember in a general way the figures as to strength or numbers, but the important basic principles involved are not usually understood. The important thing to remember is that the new law simply provides that our traditional citizen army be organized in time of peace instead of being extemporized, as in the past, after danger has actually come.

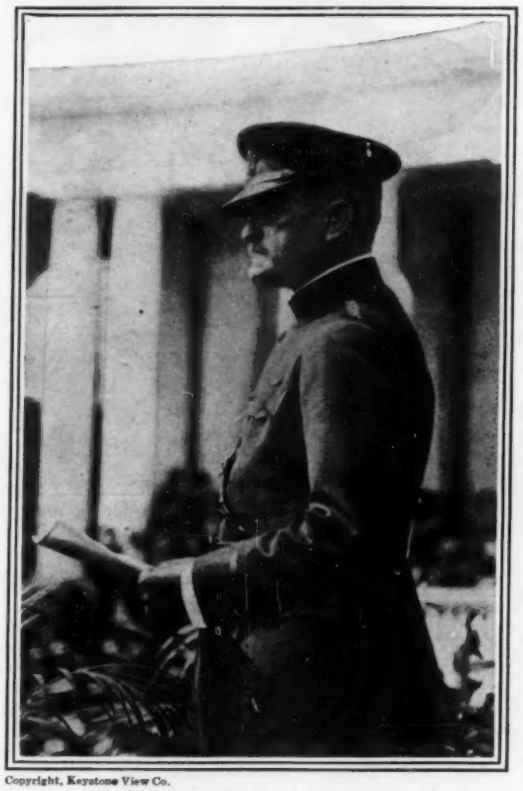
The new law provides for a real national army consisting of the Regular Army, the National Guard and the Organized Reserves. It provides for the maintenance of our forces on an economical peace basis, readily convertible to a war status. The machinery of mobilization is thoughtfully foreseen and not left to decision in the midst of a crisis. Arrangement is made for the continuous flow of trained officer personnel from the youth of the country into the National Guard and the organized reserves.

In direct contrast to the haphazard practices of the past, the new organization is built on the practical framework of the organization actually created in the World War. Thus the traditions, esprit and prestige of our great war units are to be perpetuated. They will become permanent institutions in the great citizen army that must always fight our battles. The prestige of the divisions that fought at St. Mihiel and in the Meuse-Argonne will remain a potent influence, not to be dissipated and lost like that of the organizations that fought at Vera Cruz and Chapultapec, or at Gettysburg and Chicamauga.

The organization is frankly based upon our traditional policy that we should maintain a small regular army in time of peace and that this small peace force should be augmented by great forces of citizen soldiers upon the occurrence of war. Under this systematic arrangement the Regular Army provides the general professional overhead necessary for the current administration of the Army of the United States as a whole. It furnishes the garrisons required for our foreign possessions, such as Oahu and the Canal Zone. It supplies a small force within the continental limits of the United States to stand behind the Executive and the courts in the enforcement of law and order in the time of internal disturbance. It guards our frontiers against lawless aggression. But most important of all it provides the professional personnel required for the training and development of the National Guard and the Organized Reserves and to prepare young men in our schools and colleges and in the civilian military training camps for duty as a part of our citizen army.

Our Regular Army has always been so small as to be almost negligible in the event of a great war. Therefore the National Guard must be prepared to take the field and support it as a first reinforcement in the event of an emergency. This force must be trained and organized, ready to deploy upon the declaration of war as the first line of the citizen army behind which the Federal Government will mobilize the additional troops required for the full prosecution of a serious war.

The Organized Reserves will constitute the largest group in our war armies. For economic and other reasons these reserves cannot be maintained at strength in time of peace. Only a skeleton force, consisting of trained officers, noncommissioned officers and specialists is possible. But this organization must be prepared, upon mobilization, to receive and train its full quota of war recruits. Assigned to specific organizations, these



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General John J. Pershing

reserve officers and noncommissioned officers will keep in touch with the Army by correspondence courses, lectures and short summer camps, and will thus prepare themselves for the specific duties that would fall upon them in the event of emergency.

In our high schools and colleges are Reserve Officers' Training Corps units conducted by selected Regular Army officers. Their function is to qualify the best type of young men for reserve commissions as second lieutenants in the various arms and services. The citizens' military training camps will also contribute to the production of commissioned personnel. So far as practicable the flow from these sources should be first into the National Guard. Those whose business and domestic relations are unfavorable for National Guard service, as well as those who have already served a term in the National Guard, should pass into the Organized Reserves.

In organizing the Army of the United States in time of peace, it is the policy of the War Department to maintain units in that one of the three authorized categories of troops which is least expensive and will permit of its deployment when needed. For example, it would be unnecessary and extravagant to carry on the rolls of the regular establishment the large number of special troops, such as heavy artillery, corps and army pioneer and engineer regiments, which could not be utilized until the nation was prepared to deploy its great field forces. These units can most economically and also satisfactorily be maintained in skeleton form as a portion of the reserves.

Any plan that contemplates our taking the offensive immediately upon the outbreak of a great war is impracticable because of the immense expense involved in time of peace, and is impossible because it would not be in keeping with our national ideals. The existence of such a great armed force would be militarism of a pronounced and objectionable type. Therefore our initial role on land must be defense against sudden invasion while we are completing our full war organization. It is the National Guard with our small Regular Army which is charged with the fulfillment of this mission. Later, as our full power is developed, it is the National Guard and the larger Organized Reserves, supplemented by the regulars, which must carry the war to a triumphant conclusion.

On this premise then, the National Guard will be trained and equipped for defense warfare at the start, presumably along the coasts or land frontiers. Later, after it has taken the field, it can further pursue its training and add to its equipment and impedimenta in preparation for the more exacting phases of mobile warfare. During this interval, the Organized Reserves will mobilize, recruit and train under direction of Corps Area Commanders and the entire military establishment will thus be developed systematically and to such extent as may be necessary.

Contrast this with our situation in 1917. Then, such little organization as we possessed was concentrated in the War Department. The training of an officer personnel had first to be undertaken. Huge cantonments, great artificial cities, had to be constructed at enormous expense, the railroads became jammed with material and personnel, and a previously unrelated mass of individuals herded together for training by officers previously unknown to them and in general with three months' prior military experience.

Under the new system, each Corps Area Commander has charge of mobilization within his area and transmits his orders to the three categories of organizations under his command. The consequent results as to the Regular Army and the National Guard require no comment. The greatest contrast is found in the mobilization of the Organized Reserves. Here a skeleton of each organization exists, with trained officers and noncommissioned officers, who know their places and are prepared for their responsibilities. It is they who would recruit and train locally these smaller units, gradually assembling them up to brigades and divisions. They will carry out most of their training in the vicinity of their own homes with their families and friends around them.

Imagine the difference in morale at the outset between such a unit with the proud record of its services in a previous war and with the businesslike procedure of its development, and that of a regiment in the National Army of the World War, which was thrown together with no background of achievement and a complete absence of previous relationship among its components. And, finally, contrast the National Guard and the Regular Army, holding a secure "national position in readiness," while the greater army of reserves is being formed, with our ignominious plight during the first year of the late war, when we were forced to depend upon the armies of France and England to defend our interests until the American Expeditionary Forces could be brought into the field.

At this moment, Congress is engaged in considering drastic reductions in our professional personnel, and in the sums estimated as necessary for the training and equipment of the citizen forces. No thinking man can be justified in demanding a large standing army, but there is an absolute minimum below which it is highly dangerous to reduce. The obligation of the professional soldier to defend our colonial possessions, particularly the important outposts of Hawaii and the Panama Canal, and to carry out duties explicitly set forth in the law for the organization and training of the citizen forces, remains unchanged.

Many people seem to lose sight of the fact that our new military law is itself an economic measure of fundamental importance. Our history reveals that most of our national debt and most of our wasted expenditure

(Continued on page 142)

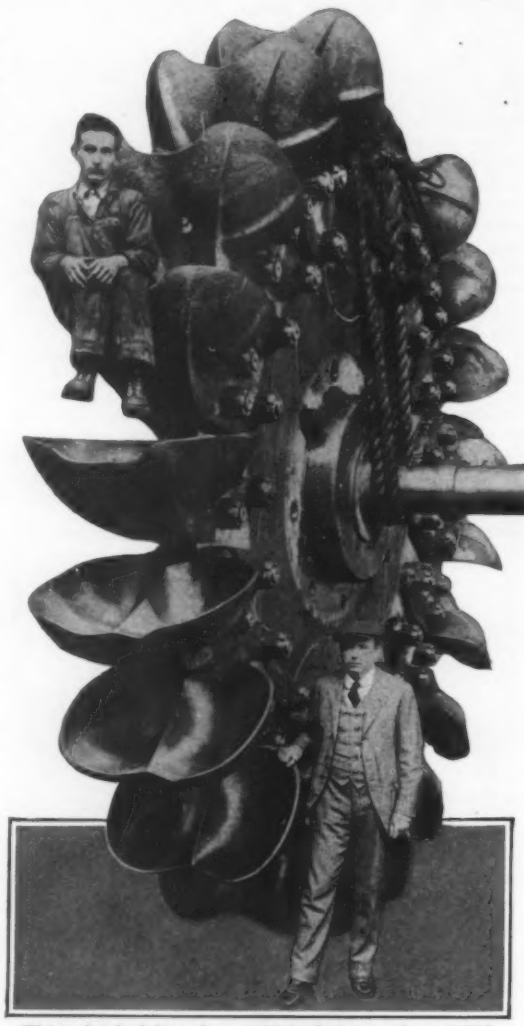
The Caribou Hydroelectric Plant

Thirty-Thousand Horsepower Impulse Turbines, Under One Thousand and Eight Feet Head

A SIXTY THOUSAND hydroelectric installation has recently been completed as the first installment of the Caribou plant, on the north fork of the Feather River. This river rises in the Sierra Nevada mountains, some 200 miles north of San Francisco, and flows into the Sacramento. In the upper half of the river there are 640,000 potential horsepower in a fall of about 5000 feet. To develop a portion of this there was built in 1913 the Big Meadows, or Lake Almanor, Reservoir on the north fork of the Feather River. It was formed by building an earth dam, 600 feet long, across the valley. The capacity is 300,000 acre-feet; but the site is such that the crest can be raised 28 feet higher, and this would provide a storage of 1,250,000 acre-feet. By consulting the map it will be seen that a tunnel has been driven from the lake to a nearby valley, through which runs Butt Creek. This tunnel measures about 7 feet by 7 feet, and is built with a concrete floor and timber walls and roof. From the tunnel the water enters Butt Creek, down which it flows for about 6 miles to enter a small reservoir formed by a dam 30 feet high thrown across the valley. The surplus is spilled around one end of the dam, and at the other end the water is conducted into a tunnel, consisting of a circular, concrete tube, 10 feet in diameter, which has a length of 9200 feet, and carries the water to the edge of the gorge of the Feather River, where it empties into a circular pressure tunnel 9 feet 8 inches in diameter. This tunnel is built of heavily reenforced concrete, and to insure absolute watertightness a diaphragm of 3/16-inch steel is embedded in the circular wall of the tunnel, and acts as a central core; that is to say, the tunnel consists essentially of a thin steel pipe, with a thick wall of concrete on each side of it. The tunnel, as it breaks through to the surface of the gorge, leads into two steel pipes, each of which is 5 feet 6 inches in diameter, and 1335 feet long, the steel increasing in proportion to the water pressure from 9/16 of an inch to 1⅛ inches in thickness. Each of these 66-inch pipes, before reaching the power-house, divides into two 42-inch pipes, which lead to the two impulse wheels, which, together with the generator between them, constitute a unit.

The Caribou plant contains for the present two 30,000 horsepower units, with foundations in place for a third. The plans for extension call for the doubling of this capacity. These are the largest of their type in the world, each unit having a normal capacity of 30,000 horsepower, operating under 1008-feet head at 171 revolutions per minute. Each unit consists of a generator and two impulse wheels, one placed on each end of the shaft. These wheels are independent in their action, each having its own pressure regulator, gate valve, etc. The governors and pressure regulators are not interconnected, except that the former have their flyballs driven from the same shaft. The nozzles of these units are capable of delivering jets 11 inches in diameter. The nozzle inlets are 38 inches inside diameter and are connected to the penstock by long-radius elbows flaring from 38 inches to 42 inches. The hydraulically operated gate valves are 42 inches in diameter and are located immediately outside of the power-house. The main shaft carrying the two wheels with the generator between them is approximately 30 feet long, 24.75 inches in diameter in the bearing, and has a maximum diameter of 30 inches. The journals are 72 inches long. The finished weight of each shaft is 26 tons, and the billet from which each shaft was forged weighed approximately 50 tons. Each wheel is equipped with 21 buckets which are approximately 3½ feet wide, and weigh 1000 pounds each. The complete unit occupies a floor space of 40 by 30 feet.

The full load on each bucket represents an impact of 86,000 pounds, and when it is considered that this force is applied 171 times per minute, the question of stress becomes vital. Some indication of the extent of this force can be had by considering that each bucket receives an impact from a mass of water possessing energy equal to that of a 2000-pound automobile going at the rate of 50 miles per hour, or a loaded five-ton truck at 22 miles per hour, and brought to a dead stop within a distance of 6 feet. Considering further that these automobile equivalents are smashed against each of the 21 buckets 171 times per minute, 24 hours a day, and perhaps for months at a time without a single intermission, some conception can be formed as to the punishment to which the bucket and its fastenings are subjected.

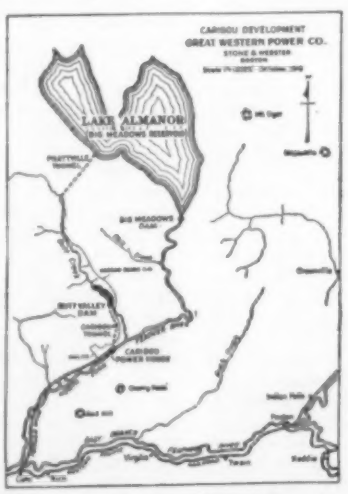


This wheel, driven by an 11-inch jet, under a 1008-foot head, develops 15,000 horsepower. It is the largest ever built

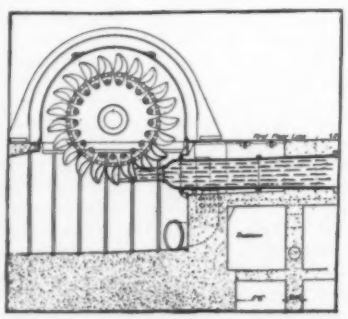
The disc is made of oil-tempered, forged steel of special high tensile characteristics, and is approximately 11 feet in diameter and 7 inches thick.

The weight of the generator rotor is 160,000 pounds. The weight of each wheel assembled with the buckets is 55,000 pounds; the shaft weighs 52,000 pounds; and the total for one wheel and its accessories is 220,600 pounds, or 441,200 pounds for a pair of wheels without the generator.

It should be made clear that each complete unit consists of an electric generator, direct-connected to two 15,000-horsepower impulse turbines, the three elements being carried on a single shaft. The whole weight is mounted upon two bearings only, these being placed between the generator and the wheels, which are overhung. The design of these bearings called for very careful planning and construction. They each carry, under full load, 200,000 pounds, and they are of the self-aligned type, equipped with forced feed lubrication, which may be used continuously, or in emergency, as desired. Necessarily, the dimensions, for such heavy duty, run to high figures—each bearing being 24¾ inches in diameter by 72 inches in length. We are indebted to Mr. Albert A. Northrup of Stone and Webster, and to Mr. W. M. White of Allis-Chalmers for data furnished for the preparation of this article.



Map of the Caribou Development



Section showing a 15,000 H. P. wheel with inlet and 11-inch nozzle

Dreams of the Blind

SINCE Freud's studies on dreams, the interest shown in this psychological phenomenon has grown considerably. We recognize the state of unconsciousness with its limitless possibilities of association as the source of dream fantasies and we know that the state of consciousness narrows the range of our view and just confines us to a world which is perceptible to our senses. In our waking hours, in every intercourse with our fellow men, we criticize our every thought, continually ask ourselves whether we ought to do this, that or the other thing, whether we will be blamed for doing something that we ought not to do or for neglecting to do something that we should; we seem to depend greatly on the good will and opinion of our neighbors. In the dream state everything is permissible. We kill those we hate, others we crown; we play the millionaire or the beggar; we step from the tower to ground and then back again to the tower; the most impossible is possible in countless variations, deeds are much more variegated and filled with much deeper meaning than in our conscious state. The artist in us wakens when we sleep.

The most remarkable characteristic of the dream is found in the optical pictures, that roll before us in kinematographic fashion, pictures of rare phenomena of no reality, the thoughts of each normal person experienced in hallucinatory acts. In dreams we are paranoiacs with abnormal imaginative powers; we multiply everything by 1000 and place ourselves, our own ego, in the center of the world.

The most primitive sort of dream is the one in which a wish is realized. The child obtains the toy most longed for in its dream. As it grows older and disillusions and disappointments crowd one another in life, the dream takes another form; it becomes the dream of anxiety and later all the passions become sources of dreams. The play of the passions takes plastic form in pictures, less often in sounds and only very seldom in hallucinations of taste and odor. The fact that sensations of touch are so rarely of any significance in dreams while in our waking state we are constantly making use of this sense must appear very remarkable to us. Our fantasies are stimulated mostly by optical and acoustic sensations.

Consequently, it was at first very astonishing to hear blind people tell of dreams in which the sensation of touch was preeminent. They are difficult to describe, because we are unfortunately accustomed to perceive almost everything optically and dislike exceedingly to abandon this agent of interpretation of experience. In this manner the blind person dreams of a fictitious battle in which he plays the principal role. This is the same sort of a dream that is experienced by a normal person, but with the difference that no element in the dream is sensed optically but only through touch.

Only those born blind dream exclusively dreams of touch sensations. Those who become blind in after life, who are forced to exchange their optical conception of the world's panorama for one in which the sensation of touch plays the dominant part, experience dreams of a corresponding nature. That is, the optical dreams gradually cease to occur; at first they are mixed with dreams in which the touch sensation prevails, but finally they are entirely displaced by the latter. The dreams of the blind have been found to be full of life, a fact which cannot be made to jibe with experimental psychological investigations. A paradoxical condition exists here in the fact that the semblance to reality of the fantasmagorical pictures in the dreams of people who have suffered the loss of one or more senses is increased in comparison with persons who are in possession of all their senses. —From an article in *Die Umschau*, 1922, 299, by Dr. Emil Lenk.

The Unification of Communication Engineering

The Present Trend Toward Our Vast System of Radio and Wired Wireless

By Major-General George O. Squier

Chief Signal Officer, United States Army

ONCE upon a time—fairy tale phraseology, to be sure, but then the history of radio reads quite like a fairy tale—the radio telegraph and radio telephone were said to be the rapidly growing rivals of the telegraph and telephone and cable systems. Some less conservative radio workers did look forward to the day when radio would take the place of these "guided" communication systems; reckless stock promoters promised it to gullible investors. Strangely enough, the unexpected has come about: instead of being rivals, the radio telephone and radio telegraph are the partners of the telegraph and telephone and the cables. Radio methods are even being employed with wire and cable lines in the case of "wired wireless." Thus we are fast coming to the day when all communication systems will be unified, and we shall have just two main divisions of communication engineering—"guided" and "unguided" communication, meaning that which is confined to a definite path by means of conductors, and that which is propagated or broadcasted through space. It is this phase of radio development that we have asked Major-General Squier to describe for you.—THE EDITOR.

THE Editor of this journal has asked me to give a short review of the present status of communication engineering, now in such rapid process of development, which might possibly serve to clarify the general situation.

On the one hand we have "space radio" stations being constructed rapidly throughout the world and already in active competition with submarine cables, while at the same time there are more submarine cable extensions planned for the immediate future than at any time in the history of the world. On the other hand, we see the close linking up of "space radio" in the same circuit with both "line radio" methods and the ordinary audio frequency telephony and telegraphy. The question is often asked: Will the long-distance radio circuits injure or suppress the submarine cable, or will they stimulate the extension of the submarine cable net in the same manner that the telephone, when invented, stimulated the telegraph, instead of superseding it? There is evidently a tendency to unification which has been going on for sometime.

Almost exactly 25 years ago—namely, on April 21, 1897, the writer, in conjunction with Professor Crehore, proposed a new system of rapid telegraphy by means of electromagnetic waves guided by wire lines.[1] This system was tried out over the telegraph lines of the British Post Office in the summer of 1897.[2]

In 1900 the same method was adopted in experiments over an Atlantic cable.[3]

In 1910 the same general principles were adopted in the "wired wireless" experiments, only in that case much higher frequencies were employed and engineering methods suitable for these high frequencies were used.[4]

In 1915 an improvement in the form of modulation in the case of the very low frequencies for ocean cables was introduced and proposed in a paper before the Physical Society of London.[5]

Later, in 1920, the same ideas were embodied in experiments upon bare wires laid in water,[6] and most recently the same general principles were employed in some experiments in broadcasting over power lines and lighting circuits.

It is of very great importance at the present time for engineers to interpret accurately, if possible, the present engineering tendencies in all of these different classes of electrical communication. Particularly is this true of submarine cable development, which, although one of the oldest forms of telegraphy, has, until recently, lagged far behind in its technical development. The fundamental principle of the cable system proposed by the author in 1915 was the c. w. or continuous wave system versus the "spark" system of the present art. This principle opened up the possibility of multiplexing, which has been entirely impossible by the old "spark" system.

In all of these methods of communication, whether it be the submarine cable, or "wired wireless" or broadcasting over power lines, the fundamental principle involved is the idea of guiding the electromagnetic waves by wires suitably controlled for signalling purposes.

I have felt that I cannot, perhaps, do better in complying with the request of the Editor than to reproduce without change some remarks made at a meeting of the Institution of Electrical Engineers of Great Britain in London on the 20th of January, 1916, over six years ago, where it was indicated that the tendency of the future development of all methods of electrical communication is founded upon the basic principle of electromagnetic waves guided by conductors. The address follows:

In thinking over something pertinent which might be said on this subject, and in view of the unusual number of telegraph experts present this evening, it has occurred to me that it would be best, in an effort to contribute perhaps something constructive, to call attention to the desirability at the present time of a careful stock-taking of the whole of telegraphy, from beginning to end, to see where we stand in the matter, and perchance to profit by certain tendencies now developing. In the newest branch of telegraphy, the so-called wireless telegraphy, we find that during the past 16 years, due to the way in which the subject has appealed to the imagination of all classes, some of the best trained minds of each country, as well as a large number of practical engineers and a host of amateurs, have been attracted to assist in the solution of the manifold problems presented. This has resulted in the accumulation of a vast storehouse of engineering and physical data traceable directly or indirectly to this new and fascinating field. In this phenomenal development we see a good example of the wisdom of borrowing freely from other arts whatever is necessary for our purposes. The radio engineer has taken from the power engineer his low-frequency dynamos, power transformers, etc.; from the older art of wire telegraphy, keys, sounders, buzzers, Morse printers, choke coils, etc.; from the pure physicist, some of the most refined of his laboratory efforts, and now he threatens to appropriate Mr. Orling's long-cable jet relay, and Mr. Heurtley's cable magnifier. In addition, he has completely broken down the barriers between telegraphy and telephony, since in his hands each radio telegraph circuit becomes a telephone circuit by merely substituting the microphone for the telegraph key. I do not criticize this procedure, I recommend it to members' serious attention. We find, in fact, that the reborrowing process has already begun, and in the case of the New York-San Francisco telephone line, one of the principal factors in final success was due to an instrument originally developed as a receiver for radio telegraphy and telephony. It would appear that the word "wireless" is an unfortunate one from an engineering standpoint. The radio engineer is strictly limited in all his efforts to the propagation of alternating currents either within, upon, or along metallic wires, and none of his skill can change in the slightest degree the character of the ethereal part of the circuit between the antennae. The moment the energy breaks away from the wires he has lost all control until, or unless, it again comes in contact with other wires. On this view, therefore, radio engineering appears merely as an extension of the much older art of wire telegraphy, and there is no such thing as wireless telegraphy. A radio station may exhibit within itself the whole range of phenomena from an alternating current of low frequency propagated by conduction through metal, as is the case in the primary generator circuit, up to this same energy transformed into an alternating current flowing along the wires of the antenna at a frequency which makes the radiation factor, instead of the conduction factor, the predominant one. It seems possible that some day we may be able to have a perfectly general telegraph equation which will contain sufficient terms to apply to any case from pure radio transmission, through wire practice, down to ocean cable telegraphy, by substituting the proper value of n, the frequency. In such an equation, of course, the radiation terms would entirely disappear for low values of n and would reappear gradually as n is increased, until we come to the case of pure radio transmission. If we glance, for a moment, at the other end of the engineer's scale of possible frequencies, we go below the normal range of power frequencies, viz., 50 or 60 per second, and enter a region as yet wholly undeveloped. In this region falls the whole of the present ocean-cable practice. The strange thing about a 2000-mile ocean cable constructed with practically no leakage or inductance is, that we arrive at a state of affairs very similar to the wireless case with antennae, although the phenomenon is one of conduction and not radiation. In other words, it appears that in such a case we may consider short portions of the cable at the ends as a sort of "submarine conduction antennae," which we design and use to launch the power on to its path across the ocean; and, on this view, the real ocean cable, which should be practically uniform throughout, begins 100 miles or so from shore at each end, and the end pieces should be considered more as a part of the station equipment than as part of the real ocean cable. These end pieces we can load with inductance and adjust to a maximum reading of a hot-wire ammeter exactly as we do with the radio antennae. Furthermore, upon examining the essential transmitting circuits we find them an exact duplicate of the radio transmitting circuits, with the exception that the inductances and capacities required are microfarads and henries, instead of thousandths of a microfarad and millihenries. We see also that the amount of power we can put into this kind of antenna is directly proportional to the square of the voltage used, and therefore one of the first moves to be made for real progress is to design the end pieces to take much higher voltages, say from 100 to 500 volts at least, and then so distribute the copper and gutta-percha in the deep-sea portion of the cable as to produce minimum line loss in attenuation of the waves. As to the intermediate cases between ocean cables and pure radio telegraphy, which would include the whole of land-line telegraphy and telephony on pole lines, here we

(Continued on page 142)

[1] Transactions of the American Institute of Electrical Engineers, Vol. XIV, "The Synchronograph."

[2] Journal of the Franklin Institute, Vol. CXLV, "Tests of the Synchronograph on the Telegraph Lines of the British Government."

[3] Transactions of the American Institute of Electrical Engineers, Vol. XVII, "A Practical Transmitter Using the Sine Wave for Cable Telegraphy, and Measurements with Alternating Currents Upon An Atlantic Cable."

[4] Transactions of American Institute of Electrical Engineers, Vol. of May, 1911, "Multiplex Telephony and Telegraphy by Means of Electric Waves Guided by Wires."

[5] Proceedings of Physical Society of London, Vol. XXVII, Aug. 15, 1915, "On An Unbroken Alternating Current for Cable Telegraphy."

[6] Journal of the Franklin Institute, June, 1920, "Multiple Telephony and Telegraphy Over Open-Circuit Bare Wires Laid in the Earth or Sea."

Our Point of View

A Sea-Level Canal at Panama

WHEN the Board of Consulting Engineers of the Panama Canal reported to President Roosevelt in favor of a sea-level as against a lock canal, that great American, never shirking responsibility, adopted the minority report in favor of a lock canal. The President realized that millions of money and years of time would be saved by adopting the lock system. Little did he or his engineers know what a pitfall they had avoided in refusing to cut down an additional 85 feet into the treacherous material of the Isthmus. The peril was realized only when the whole mountain side at Culebra and Cucuracha began to slide into the canal. Had the attempt been made to cut the canal down to sea-level, the material that would have had to be removed would probably have been between two and three times as much as the total of nearly 400,000,000 cubic yards which had to be excavated to secure the present high-level or lock canal.

Commercially and militarily the lock canal has been a notable success. Traffic has increased so rapidly that the day is approaching, if it is not already here, when the engineers must give anxious thought to the future. This concern does not spring from any fear as to the permanence of the locks or the great dam at Gatun. Nothing short of the malice of man, hostile bombing by hostile forces, or a cataclysm of nature, can wreck the Panama Canal. Anxiety as to the future is due to the fact that the filling and emptying of the locks at Panama calls for a large and unfailing supply of water. This water is derived from the Chagres River, upon which the maintaining of Gatun Lake at a constant level of 85 feet above sea level depends. In the year 1919 there passed through the canal just under 7,000,000 tons of shipping. In 1920 the total had risen to over 10,000,000 tons. The Government report shows that in 1920 the lockages necessary to pass 10,000,000 tons, expended 770 cubic feet of water per second, and for the hydroelectric plant, which furnishes power for the operation of the canal, 1,703 cubic feet per second was required. Taking this as a basis, it is found that if, and when, Panama has a traffic equal to the 45,000 tons that has passed in a single year through the Sault Ste. Marie canal, there would be required a total water supply, for lockage, for the hydroelectric plant, and to compensate for evaporation, of about 6000 cubic feet per second, the year around. Now the Chagres River cannot be depended upon to supply 6000 cubic feet per second continuously, nor any quantity approaching that figure.

Enough has been said to show that the outstanding fact in approaching the question is the limited total water supply available. No ingenuity of man can add to that total. Hence, it is obvious that the only solution of the problem is to undertake the gigantic task—and it will be truly gigantic—of excavating the high-level section of the canal from Gatun to Miraflores, a distance of 35 miles, down to 45 feet below sea-level.

Bunau-Varilla, Chief Engineer of the canal when we took it over from the French, was ardently in favor of the construction of the canal at sea-level, and in an article which he wrote for this journal at that time, he advocated the digging of the canal by the hydraulic method, that is to say, by keeping the summit-level flooded, and excavating the material by powerful bucket dredges. He called the sea-level canal, of which he was so ardent an advocate, "The Strait of Panama."

No engineer can well dispute his conclusion that the use of this method would greatly decrease the cost. We believe that the improvements in hydraulic dredging, including the greatly increased capacity of modern dredges, would enable the hundreds of millions of yards of excavation to be carried through at a unit cost so low, as to render the financing of the project from the profits of the canal a feasible proposal.

To Render Street Traffic Fluid

IF we get the right point of view of the problem of congested street traffic in cities, we shall realize at once that it can be relieved most quickly by making street traffic fluid. It is the fluidity of water which accounts in a large measure for the great volume of it that we can pass through a channel of given cross-section. Except for the frictional resistance where the stream comes in contact with the sides of the conduit, the flow is unobstructed, the particles of water offering no opposition to one another as they pass onward; each one being free to overtake and pass by others that may be for the moment moving less rapidly, without any general slowing up of the progress of the whole mass. The best point from which to study the flow of human traffic is from the top of some tall building, from a point of vantage, for instance, such as the observation platform of the Woolworth Building. From such an elevation the mass of traffic opens out with wonderful clearness into its individual units, and the traffic movement, both on the streets and on the sidewalks, can be made the subject of a very informative study.

Viewed from the top of a tall building, the first thing to strike the observer is the far greater fluidity of the human traffic on the sidewalks, as compared with the vehicular traffic on the streets. The foot passengers overtake and pass around one another, particularly if the unwritten rules of the sidewalk are followed, with wonderful freedom from congestion. The individual who is in a hurry has the whole width at his disposal, and automatically he seeks the openings as they present themselves and moves forward with a speed little less than he would were the sidewalk empty. But on the streets, particularly if they are encumbered with trolley tracks, this fluidity practically disappears, and it takes only a brief study from the air to be impressed with the obstruction to the free flow of traffic which a line of street cars presents.

Even more obstructive is the street crossing. It would be very interesting if some student of the problem would make a close analysis of the delays due to trolley lines and street crossings, and ascertain to what extent the capacity of a thoroughfare is cut down by these two sources of delay. It would be quite possible to make a fairly close estimate, and the results would undoubtedly be startling.

New York City, with its present population of six millions, has a rate of growth so rapid that unless drastic steps are taken to provide for the transportation problems of the future, the city is bound to find itself in certain congested thoroughfares at a positive impasse. Steps must be taken, and taken very quickly, to provide for this ever-rising flood of human traffic. The Transit Commission has outlined a scheme for the extension of the subway system, and the improvement of the lines which already exist. In our opinion, this work is more pressing than any other confronting this city today. It should be pushed forward to the utmost limit that the finances of the city will allow.

But it is with street traffic that we are at present concerned; and the question of the hour should be: How shall the turgid stream that creeps through our congested thoroughfares be rendered fluid? How shall we meet that day, which is not far off, when the crowds of people, and the masses of vehicles, will grow so dense as to be practically incapable of movement? The first and most efficient remedy would be to carry the east and west streets over the principal north and south streets, by means of overhead structures, thereby obtaining an uninterrupted flow and abolishing the present abominable intermittent traffic, with its incalculable loss of time. All the streets need not be so provided at first. Bridging at every third or fourth street would be sufficient; the east-and-west traffic crossing the main thoroughfares by these elevated structures and by these alone.

The next important solvent of the congestion would be to eliminate all street railways from the densely-travelled city centers, and leave the streets free for automobiles and motor trucks.

A third provision, which is a natural corollary of the second, would be to assign certain streets to one-way traffic. If by some magic touch these changes could be made over night, the city would wake up on the morrow to find that its capacity for traffic on its main thoroughfares had increased, we venture to say, 50 per cent, and probably much more than that.

Colleges and Common Sense

SO much of downright misrepresentation and of irresponsible comment has been heard in the matter of the college entrance requirements that a fair statement of the facts seems in order. And the fact that every critic should first get straight is that all our colleges of rank have applications for admission from far more students than they can accommodate. Some day, we hope, it will be otherwise. But today neither the space, nor the physical equipment, nor the instructors, are available for all who seek the university training; funds to make them available are not in sight; and if these funds were actually in hand, their conversion into units of education could not be immediate.

One way of facing these facts is oratorically, by impassioned reference to our national wealth and the iniquity of slamming the door of opportunity on any applicant. This is very pretty but it does not build lecture halls or pay professors' salaries. We may, if we so elect, use existing facilities in giving to all applicants such education as is possible with crowded class-rooms, insufficient instructors, inadequate laboratory and library equipment. But we must not forget that this depreciates education; and that education, like currency, once depreciated, is with the utmost difficulty brought back to par.

It is better, after all, not to start the depreciation process. Let us admit frankly that education spread out thin over a thousand students with the facilities that would be proper for a hundred is a pretty poor article—no better than the students could pick up themselves, with less labor and at less cost, by the self-imposed reading which has been the means of the self-education of thousands of successful men. We may regret keenly that we cannot accommodate all comers in our colleges; we may work desperately to enlarge the accommodations. But let us, by all means and at all times, restrict the enrollment to just so many students as may be cared for properly.

This implies that some method of discrimination among the applicants must be practiced. And since education is justified as much by its community benefits as by its direct value to the individual, we may with propriety contemplate the exclusion, before we have wasted the college on them, of those whose attempted education would be least profitable to themselves and to us. The man who embarks upon the work of the Freshman year must keep going or drop out. Many do drop out, on their own initiative or otherwise. So much of the colleges' limited facilities as has been devoted to the effort to educate these men is then wasted; and what is worse, a corresponding number who might have made good have been excluded. While college facilities are inadequate, it is essential that these men, so far as they can be identified in advance, be denied the privilege of demonstrating by concrete failure that college is not for them. And the colleges have decided that a test directed to actual character and intelligence rather than mere ability to remember things out of a book would catch a larger proportion of these potential failures.

The new entrance tests include questions about the candidate's school record; they ask for specific statements from former teachers as to just what manner of man he is. This is done, not for the mere pleasure of inquisition, but because in the average case it affords

Our Point of View

the best lead for determining what manner of man the candidate is. Our college administrators do not need to be told that the self-educated man and the one who has left the source of his education 5,000 miles behind him are not in a position to show, in just the same way as the boy from Lawrenceville or Groton, what manner of men they are. It ought not be necessary to assure any honest critic that the entrance boards are prepared to make every concession that special circumstances may demand, in permitting candidates to show in other ways what manner of men they are.

Another plea that has been made against the intelligence test that is replacing the old style of memory examination is, that it spells race discrimination. There is a type of student that is long on memory and short on common sense. We knew one such, who could recite verbatim several pages of instructions for setting up and operating a surveyor's transit, yet who could not make the first move toward putting them in effect; his exclusion from college would have benefited both him and the institution. By persons of other race than the one in question, this mental characteristic is often advanced as a racial trait. The suggestion, ordinarily, is of course indignantly repudiated by members of that race; but these same gentlemen are now rushing into the public prints with the claim that tests which exclude men of this type are aimed at their race. In other words, when their purposes seem to be served by so doing, they seize upon this extremely uncomfortable shoe, and insist that it fits!

The man whose intelligence runs all to memory is not the man who can best assimilate, or who most needs, the college training. Until we are able to give this training to all, we may very well ask him to stand aside, and do his remembering out of a book instead of from a lecture. We doubt that men of this type will stand in any different ratio, as regards race, than the applicants for college admission as a whole. To those of them who chance to be of any stated race, we recommend strongly that, if they must appeal from the verdict, they appeal on grounds other than those of race. It is not a racial matter, unless they make it so.

Brands That Mean What They Say

THE textile trade has been guilty, more than any other, of an ingenious and ingenuous misuse of the English language. Grades and qualities of goods are necessarily more closely appraised and more closely defined by the manufacturer and jobber than by the consumer. It must equally be the case that, in dealing among themselves, manufacturer and jobber and broker use a large number of terms to identify the numerous grades and sub-grades. The difference between "prime," "strictly prime," "extra prime," and "triple extras," for instance, cannot possibly be clear to anybody until it has been definitely established by consensus of the trade, and after that it is clear to all in the trade and to none out of it.

It has, however, gradually become the custom to use, for the designation of grades, expressions which have a very direct significance in the ordinary language of the dictionary. This is not immediately vicious; it is, in fact, a distinct gain to call a certain fabric "all wool" rather than "XY-3"—provided it *be* actually constituted of 100 per cent wool. The label "all wool" tells its story to the ultimate consumer and the label "XY-3" does not. But it has become the custom, not merely to use such significant brands as this one, but to give them, by consent of those in the trade, a secret significance different from the face value of the words. One asks the polite young clerk whether the trousers are all wool or the socks all silk and one is assured that this is the case. One buys them and is disappointed with their performance. One takes them to the microscopist and discovers that the "all wool" trousers are wholly shoddy and the "all silk" socks half cotton. One wends one's indignant way back to the store, and is met with the calm assurance that "all wool" *means* shoddy, and "all silk" *means* half cotton, and that one's ignorance of the terminology of the textile trade is responsible for one's having bought inferior goods.

We have no doubt that such tricks of terminology were originally invented for purposes of deliberate deception—however much they may have been later adopted, by houses of good repute and good intentions, to meet the necessities of competition. Now, however, the Supreme Court of the United States has taken a hand, and in a case of far-reaching importance has laid down the general principle that a brand can mean only one thing. If it has any natural significance of its own by virtue of the dictionary meaning of its component words it must mean that and only that as applied to merchandise.

Among the things which are due for an early disappearance from the market in the light of this decision are "mahogany" furniture that is really veneered; "strictly fresh eggs" that are several weeks old; "merino" and "lisle" textiles which are sold for anything that the purchaser is willing to accept them for; and so on through a large list of articles—mostly textiles, as we have said, with foodstuffs probably second on the list. This is a distinct step in the rational application of the powers of the Federal Government to control the branding of articles sold in interstate commerce, and one which we hope will be extended to all fields of merchandising by specific action of honest manufacturers against competitors who adhere to the use of old and tricky nomenclatures.

The Sense of Proportion

FORTUNATE is the man who has a broad perspective and a keen sense of proportion. If, in addition to perspective and proportion, he be richly endowed with mental and moral qualifications, he may be set down at once as a genius. Someone has said that the indispensable foundation of genius is a keen sense of proportion.

Who shall say how many of the failures in life are due to a lack of this priceless quality. In the presence of a problem of more or less perplexity, the majority of men are apt to seize upon some subordinate element, and hold fast to it with dogged persistency, in the belief that they have a grip on the very kernel of the matter. Some men walk among the high peaks of thought and action; others lose themselves among the foothills. Among the former are the world's many geniuses; and to those of us who are in the valleys it is a frequent source of wonder how these peak dwellers are able to get such swift, far-reaching, and abiding results, apparently with so little effort. The answer is to be found in their possession, to a supreme degree, of the quality under discussion. Such men see, almost at a glance, the outstanding and controlling elements of any situation; rarely, if ever, do they follow a trail which leads into the jungle of perplexity—they may start upon such a trail, but they are quickly back upon the main road. This is true of all such men, be their life work what it may. It holds good of the statesman, the soldier, the scientist, the banker, and the merchant. Lack of a sense of proportion means an enormous amount of wasted energy and capital; possession of it, other things being equal, secures an unimagined economy of labor, and if not always a swift, at least a very sure ascent to final success.

It is needless to multiply instances, but there comes to mind that greatest of military geniuses, Napoleon. There was a man whose sense of proportion was so keen, and his perspective so wide, that he seemed to arrive, in a moment, at a decision which would take a dozen capable men hours, if not days, to reach. It is recorded of him that his associates would be discussing alternative plans of action, when the great general would enter, ask for a statement of the problem, grasp at once its outstanding elements, act upon them, and make a decision which astounded his generals by its conjoined daring and military wisdom. It is said that in matters of finance the late J. Pierpont Morgan showed ever this same sense of values, conjoined with the courage and ability to make swift decisions. It is needless to say that the great leaders in philosophy, science, and the constructive arts, have been preeminent in the breadth of their outlook; in their quick perception of the essentials of a problem; and in their courage to act upon conviction.

Now the object of these reflections is not to awaken in the average man the hope that he may develop into a genius. To but few men would that be possible, even were the classical definition of genius as "the infinite capacity for taking pains" well founded. But this much at least is true: The man who combines the capacity for painstaking work with the ability occasionally to step out of the rut and survey himself and his work in their true relation to the great world in which he moves—such a man will be debited with but few fruitless hours in the accounting of his life work.

Snap Judgment on Engineering Works

APROPOS of the possession of a sense of proportion and a true perspective, we venture to state that in no field of human activity are these qualities so necessary as in the planning and prosecution of great engineering works, such, for instance, as the Panama Canal, and the bold attempt to control the floods of the Mississippi River. Seldom has an engineering problem presented itself in which clear vision and bold judgment were so necessary, as when the American people were agitating the question as to whether it would be better to purchase the Panama Canal works from the French, revise the plan, and carry the great work to conclusion, with all the power of the nation behind it, or whether it would be better to ignore the discredited Panama project, and build an "All American Canal" (to use the catch phrase of the day), entirely from American plans and with American money, at Nicaragua.

The arguments in favor of Nicaragua, as set forth by the propaganda for that canal, were many and plausible—plausible, that is, to the layman. Was there not, or could there not easily be built, a good harbor at each end? Did not the route lie along a valley whose river could be canalized with a minimum of cost; and did not a long stretch of the route consist of deep-water steaming through a large lake, which lake would afford a supply of water for lockages? Plausibility was written all over this propaganda; but to the trained eye of the specialist it was evident at a glance that these supposed advantages were all incidental, and that the essential questions of stability, permanence, and freedom from seismic disturbances, had been overlooked, or cleverly glossed over.

It is thus with the costly and far-flung works for the control of the Mississippi floods. Here is a great system of engineering works, which reaches along the banks of the mighty river for a thousand miles. Both in its planning and construction the engineers have been guided by the experience of over two centuries of effort to master floods. Because of the material magnitude of the problem and its great cost, of necessity it has to be done piecemeal, as Federal and State funds become available. Being incomplete it is not, throughout its length, prepared as yet to deal with the highest annual freshets; and where the works have not been completed the waters inevitably spread out over the adjoining lands.

The engineers of the various associations, Federal and State, which have the problem in hand, ask of the public that it pass upon their efforts no snap judgments based upon individual and widely separated failures of uncompleted strips of levee. We commend to all such doubters a careful reading of the article upon Mississippi River Control, which will be found elsewhere in the present issue. Let them read it and realize that the ultimate complete mastery of the turbulent river is as certain as that the sun will rise on the morrow.

Photographs by the courtesy of the Southern Pacific Railroad

Great Fill, 8.03 miles long, forming easterly portion of Cut-off

The timber trestle, 19.45 miles long, across the Great Salt Lake

The World's Longest Bridge

The Twenty-Mile Trestle Over Salt Lake on the Southern Pacific Cut-Off

THE longest bridge ever constructed is to be found at Salt Lake, where for nearly twenty years the tracks of the Southern Pacific Railway have been carried across the Lake on a typical American timber trestle 19.45 miles in length. Originally this bridge was 27.5 miles in length; but 8.03 miles of the trestle have been replaced by a fill.

The building of this unique structure took place during that era of great activity when the railroads of America were engaged in rebuilding certain parts of their lines which, because of the scarcity of capital, had originally been constructed with steep grades, sharp curvatures and long detours, made to avoid heavy excavation and costly bridge building. The Salt Lake "cut-off," as it has come to be known, is a notable instance of this rectification of early pioneer construction. As will be seen from the accompanying map, the line from Lucin to Ogden made the circuit of the Lake and was developed along the lower foothills of the mountains. The profile shows that it was by no means an easy line, the maximum grades running from 49.63 to 89.76 feet per mile, and much of the curvature being from eight to ten degrees. The total distance between these two towns by the old line around the northerly end of the Lake was 146.7 miles.

In spite of its briny waters, Salt Lake is the home of vast flocks of seagulls

In locating the new line, it was decided to run down to the desert level, continue on a tangent to meet the shores of the Lake, and then build a trestle across to the end of Promontory Point and continue by trestle to Ogden. By this revision, 43.77 miles in distance was saved, 3919 degrees of curvature was eliminated, and the total grade was reduced by 1515 feet. The sharpest curve on the new line is one and one-half degrees as against 10 degrees on the old line. The heaviest grade now is 21 feet to the mile as against 89.76 feet to the mile on the original line. The force for completing the trestle and the equipment was planned on such a scale as would enable the trestle to be built at a rapid rate, and the maximum amount built in one week of six working days, working by daylight only, was 1.007 miles put up during a little over five working days. The temporary trestle was built in water which varied in depth from a foot or two up to 27 feet. The permanent trestle was built in water which was from 30 to 34 feet deep at the time of construction. Subsequently, in building the embankment to take the place of the temporary trestle, which was 8.03 miles in length, the material was excavated near the east shore of the Lake at Little Mountain, and at Promontory Point, upon which the new line was built for a distance of about 4½ miles. Material was also obtained from mountains about 16 miles west of the Lake. The railroad runs on embankment in Great Salt Lake between the east shore and Promontory Point, a distance of 8.03 miles and on trestle between Promontory Point and the west shore for 19.45 miles, making a total distance of 27.48 miles from shore to shore. It is an interesting fact that, because the embankment between the east shore and Promontory Point almost entirely cuts off a portion of the Lake to the north from the main lake, the water of the Bear River, emptying into this part of the Lake, freshened the salt water to such a degree that in the winter immediately after the construction, ice one foot thick formed over the entire area to the north of the railway embankment.

As will be seen from our illustrations, the long trestle from Promontory Point to the west shore is an exceedingly fine piece of work. A solid timber deck was laid over the piling, and on this was placed 14 inches of gravel. Upon this firm bank the track has been laid, and along each edge of the floor is a high, stout fence. The trip across the Lake by rail is unique. As is well known, the Lake, which at the time of the construction of the cut-off was 75 miles by 31 miles wide, is one of the most remarkable bodies of water extant, and it is more salty than any but the Dead Sea in Palestine. So dense is the water that one cannot sink in it. Large though the Lake is, we must remember that it is but a remnant of an inland sea which once occupied a large part of the Great Basin; and it is estimated that over 20,000 years ago this body of water was about 350 miles

One of the several piles of salt recovered from the Lake by evaporation

long and about 150 miles wide, being almost as large as Lake Michigan and considerably deeper. The successive stages of this Lake Bonneville, as the geologist calls it, are still to be seen in the terraced rocks marking its successive shore lines.

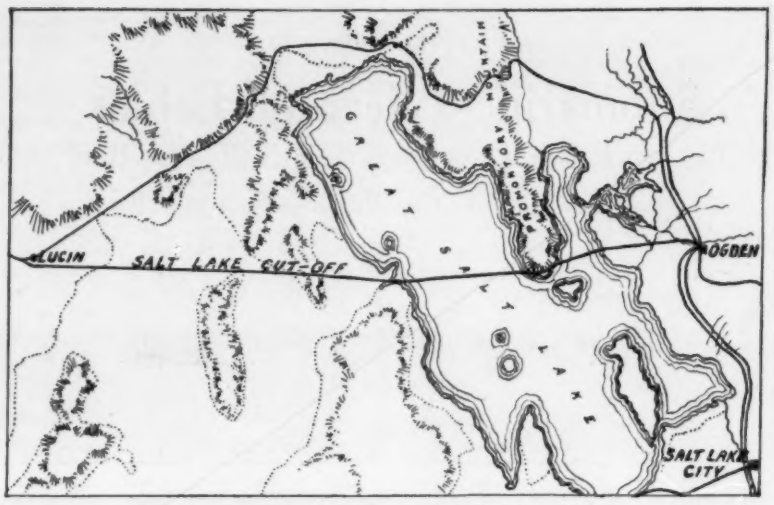
Extinguishing Fires Through Ventilating Systems

MODERN ventilating systems have become so carefully designed and well installed that attention has recently been drawn to the possibilities of using them as a direct means of extinguishing fires in industrial plants and other buildings equipped with heavy duty ventilating systems. The plans being worked out call for the storage of chemical extinguishing gases in large quantity at the intake of the ventilating system and a plan of control of the ventilation ducts and openings and exhausts throughout the plant that will permit of introducing the extinguishing gases quickly into the section of the plant where a fire starts. By this method it will be possible to fight stubborn blazes and confine them to the part of the plant where they start, with a minimum of risk and damage that is incident to usual methods of fighting fire by water and liquid chemicals that sometimes do nearly as much damage as the fire itself.

Such a method of fire fighting and control offers a very wide field for its use in many industries where fire hazards are extremely great. The storage of extinguishing gases offers no great problem as generating units of sufficient size to keep the system well charged will not occupy excessive space. Automatic control of the system is entirely possible through a series of thermal units at the outlet ducts of the usual ventilating system which, on becoming overheated, give alarms or set signals indicating the point or points necessary to flood with gases.

Inside the Atom

TRANSMUTATION of elements, the dream of the alchemist, for some years familiar to us through the natural process of radio-activity, has as yet eluded so far as its deliberate and artificial production is concerned. In a recent issue of *Science* Richardson concludes that we are measurably nearer the goal as the result of Rutherford's recent work. At the present time, he thinks, "we have to accept it as a fact that the atoms consist of a positively charged nucleus of minute size, surrounded at a fair distance by the number of electrons requisite to maintain the structure electrically neutral. The nucleus contains all but about one two-thousandths of the mass of the atom, and its electrical charge is numerically equal to that of the negative electron multiplied by what is called the atomic number of the atom; the atomic number being the number which is obtained when the chemical elements are enumerated in the order of the atomic weights; thus, hydrogen=1, helium=2, lithium=3, and so on. Consequently the number of external electrons in the atom is quite equal to the atomic number. The diameters of the nuclei of the atoms are comparable with one-millionth of one-millionth part of a centimeter, and the problem of finding what lies within the interior of such a structure seems at first sight almost hopeless. It is to this problem that Rutherford has addressed himself by the direct method of bombarding the nuclei of the different atoms with the equally minute high velocity helium nuclei (alpha-particles) given off by radioactive substances, and examining the tracks of any other particles which may be generated as a result of the impact. A careful and critical examination of the result shows that hydrogen nuclei are thus expelled from the nuclei of a number of atoms such as nitrogen and phosphorus. On the other hand, oxygen and carbon do not eject hydrogen under these circumstances, although there is evidence in the case of oxygen and nitrogen of the expulsion of other subnuclei whose precise structure is a matter for further inquiry."



Map showing how the Southern Pacific saved 43.7 miles of distance and 3919 degrees of curvature by building a bridge across the Great Salt Lake

Removing and Installing Large Turntables

AN original engineering accomplishment worthy of mention was accomplished a short time ago at Hoxie, Arkansas, locomotive terminal of the Missouri Pacific Railroad. This was in the removing of one turntable and replacing it with a much larger one.

The old turntable was constructed on a concrete center pier with concrete foundations for the circle rail and a back wall of pile and timber construction.

The new table was 100 feet long or 18 feet longer than the old one, thus necessitating the excavation for the new concrete circle, back wall and foundation for the circle wall. This was completed without disturbing the old pile circle wall. To handle this excavation, 13 feet wide and 11 feet deep, was a considerable item and to expedite the work so as to save as much time as possible the American ditcher was used. This method permitted the operation of the turntable at all times while the excavation was under way. When this work was reached the tracks leading to the roadhouse, about four tracks would be taken out at a time, and four put back in service on cribbing.

The 155 piles for the foundation of the new circle and back wall were driven without interfering with the operation of the turntable by use of a self-propelling pile driver, operating from the approach tracks to the turntable, making about six moves to complete the work.

The concrete base for the circle rail and circle back wall as well as that part of the circle back wall not under the approach tracks were completed before putting the turntable out of service.

As soon as all preliminary work was completed, the old turntable was jacked up at one end and the other end was raised by a steam derrick and an incline track constructed on cribbing. The turntable was removed from the pit supported on a car truck under and near the center of the table, with the steam derrick carrying one end to guide it as it was pulled up the incline and out of the pit.

The new table, weighing 80 tons, was taken off cars and placed on the incline track similar to the manner in which the old one was taken out. In less than six hours from the time the pit was ready, the new turntable was in its place and balanced ready for use.

Lowering the new turntable into pit by means of a truck under its center and a locomotive crane

Largest Caisson Ever Built

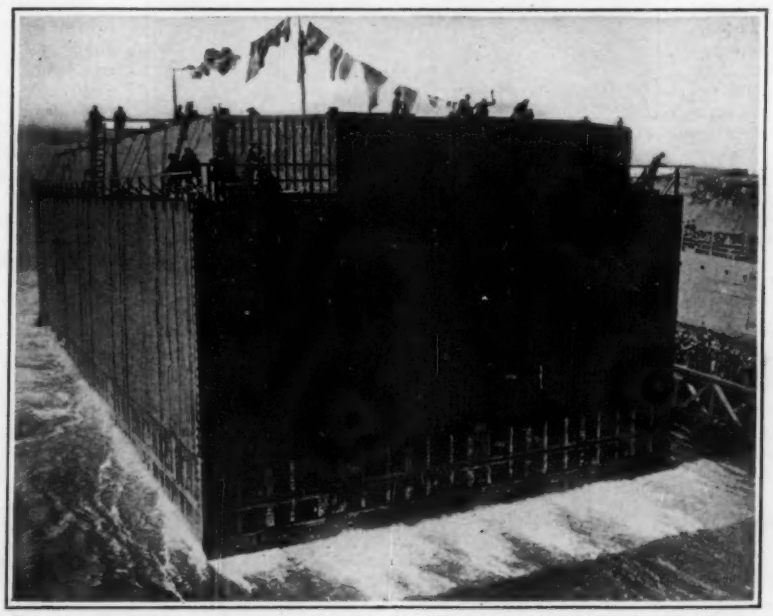
THE big, box-like structure, which is here shown at time of its launching on to the waters of the Delaware River, is a caisson built for one of the main piers of the new Delaware River bridge.

This bridge, which we illustrated and described very fully in our issue of July 2, 1921, is designed to join Camden and Philadelphia. The floor is suspended from two wire cables, each of unprecedented diameter of 30 inches, and containing 16,500 wires, 0.192 inches in diameter. The main span crossing the river measures 1750 feet from pier to pier.

The caisson measures 70 feet by 143 feet; it is 65 feet high and weighs 1600 tons. It is built partly of steel and partly of heavy timbers, its steel construction constituting approximately the lower one-fourth of the structure, the other upper three-fourths being of timber. As is usual in such caissons, the outer walls are tapered down at the bottom to a sharp cutting edge, and the bottom of the caisson constitutes a four-sided and roofed airtight working chamber, which is open over its whole bottom area. The roof of the working chamber is reenforced with heavy longitudinal and transverse trusses, which are 15 feet deep. Above this are the four timber walls which are securely bolted together, and braced with heavy timber struts.

The working chamber, 8 feet deep, is provided with five compartments, which are separated by timber bulkheads 3 feet in thickness. Each compartment contains two passageways to two adjacent compartments. Rising from the roof of the working chamber to the summit of the caisson are ten steel shafts, three feet in diameter, through which the excavated material will be raised from the river bottom. Also there is a shaft 4 feet in diameter, through which the workmen may enter and leave the working chamber. Since the working chamber is to be maintained under an air pressure equal to, or a little greater than the pressure due to the head of water outside the caisson, it is necessary to provide the material and workmen shafts with airlocks. In the working chamber the men drill and blast such rock and big boulders as may be encountered, and shovel this material, and the mud, sand, gravel, etc., into buckets, in which it is hauled up through a shaft for subsequent disposal.

The men are able to excavate up to the full diameter of the caisson—thanks to the cutting edge, which slopes outwardly, until the sharp steel cutting member is practically flush with the outer wall of the caisson.



This caisson, 70 feet by 143 feet and 65 feet high, will form the foundation of one of the main piers of the Delaware River bridge at Philadelphia

Submarine Telegraph Cables

With the Men Who Lay and Repair These Invisible Strands That Bind Continents Together

By Lt.-Col. C. deF. Chandler, U. S. Army, Ret.

THE aerial wire lines for the ordinary land telegraph circuits are so much in evidence that the methods of construction and operation are quite well known. But with few exceptions information regarding submarine telegraph cables is confined to persons associated in some way with that industry. Therefore a brief description of the cable itself and manner of laying and repairing it should be of general interest.

The electrical conductor which forms the center of the cable usually consists of a strand of seven copper wires (occasionally 11 or 19), over which is an insulation of gutta-percha or indiarubber. A stranded wire conductor is better than one solid wire of equal conductivity, because flexibility is essential during the laying and repairing operations. This cylindrically insulated conductor is known as the cable core. The quantity of copper for the conductor and of rubber for the insulation is usually expressed in pounds per nautical mile.

By way of examples, one trans-Atlantic cable has 700 pounds of copper and 300 pounds of gutta-percha per mile for a length of 2054 nautical miles. These amounts allowed an ordinary working speed of 185 letters per minute, which has been increased by magnifiers about 40 per cent. Another somewhat earlier Atlantic cable has 650 of copper and 400 of gutta, allowing a normal working speed of 240 letters per minute. This latter cable is 1853 nautical miles, and the magnifiers similarly increase the working speed 40 per cent. These rates are in both directions, as the cables are duplexed. Some short cables have only 107 pounds of copper and 177 of insulation per mile.

The Atlantic cable, with the 700 pounds of copper for the conductor, has a resistance of 1.69 ohms per nautical mile. Some of the smaller cables have as much as 21 ohms per nautical mile. The electrostatic capacity is not so variable; ordinarily it is between .3 and .5 microfarads per nautical mile. Cable core in poor condition has much less capacity. The measurement of insulation resistance or dielectric resistance is also referred to as the electrification of the cable. The results are not constant; that is, the electrification after five minutes' application of the testing current is often quite a different reading than after one minute. The result is usually stated in megohms per nautical mile after one, two or five minutes' electrification. New gutta cable core should show at least 500 megohms per nautical mile. Indiarubber core has shown 1230 megs before laying and 2500 megs after laying. The best section of the Alaskan cable system (rubber insulation) measured 3800 megs per mile after laying. All of the electrical measurements are affected by temperature changes and the capacity and insulation resistance are changed as well by the tons of pressure produced by great depths of water.

By increasing the thickness of the insulation between the conductor and the sea water which completes the electrical circuit, the electrostatic capacity is reduced, and by increasing the quantity of copper the electrical resistance is lowered, both of which permit of faster operation. The longer a cable, the greater the electrostatic capacity and resistance, consequently it is customary to design each cable for the particular place where it is to be laid, having reference to the length and speed of signaling desired.

To protect the core from damage and give it mechanical strength for laying and repairing, there is a covering of mild steel armor-wires laid helically and separated from the core by a cushion of jute. Outside the armor-wires there are two windings of jute to prevent the

Cable hands, with cable hove to bow, stoppering-off the cable at both sides below the bow sheaves

armor-wires from spreading apart or "bird-caging," as it is called. This outer jute is well tarred and finally covered with powdered soapstone to lessen stickiness of the tar in warm climates.

The smallest-sized cable is laid in the deepest water because the chances for mechanical injury are slight and armor is needed only to give the cable strength for laying and repairing. For moderate depths of water there is an "intermediate" type of cable which is similar to the "deep sea" except that the armor-wires are larger. At landings and near shore where tidal currents and wave action tend to move the cable, particularly over rocky or coral bottom, an additional layer of much heavier steel wires is provided; this double armored type is known as "shore end" or "rock" cable. The double armored types have the tarred jute and soapstone only over the outer layer of wires. Ordinarily the core is of the same size for the entire length of any one cable, including the heavy end sections. The outside diameter of cable varies from four-fifths of an inch for small deep-sea type up to 2½ inches for shore end. The weight of complete cable may serve better to indicate the type differences. Deep-sea weighs from 1½ to 3½ tons per nautical mile; intermediate from 3½ to 12½ tons; armored shore-end from 11 to 19½ tons per nautical mile.

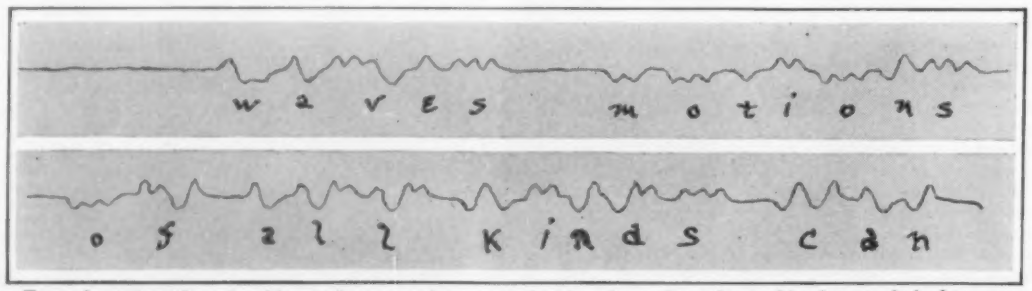
It should be apparent that submarine telegraph cables, in mechanical construction, are very different from the lead-covered telephone cables containing several hundred pairs of conductors, which are so familiar in every American city and town.

All of the trans-Atlantic and Pacific cables and in fact nearly all of the submarine telegraph cables of the world employ gutta-percha as the insulating medium. The supply of this substance is limited and seems to be controlled by British and French interests. Indiarubber is used very extensively throughout the world for a great variety of purposes and an ample supply seems to be always available.

Because of the assured supply of indiarubber and lack of experience of American manufacturers with gutta-percha, and the need for developing the cable manufacturing industry in the United States, all cables which have been made for the Signal Corps of the Army and laid in the Philippine Islands and to Alaska have had indiarubber as the insulating material. Considering reliability and durability, gutta-percha has proved to be superior, but time and cost were the factors which determined the adoption of indiarubber for the military cables, which had to be provided as quickly as possible. However, the experience which has been acquired by American manufacturers now assures rubber cables of much better quality.

Heating only slightly above ordinary temperatures is sufficient to make gutta-percha soft so that it can be drawn through a die over the conductor and easily worked by a hot iron in making joints. After being molded into the shape desired, indiarubber must be vulcanized with sulfur and other ingredients to insure permanence. When that is done, exposure to dry air or increased temperature have no deleterious effect as is the case with gutta, which must be immersed in water promptly after manufacture and constantly maintained thus. It would have been impossible to transport gutta-core cable in the dry holds of merchant vessels to and through the tropics, as was done with rubber-core cable needed at Manila. The cable required for the Alaskan system was made near New York and shipped around Cape Horn to Seattle.

The most efficient type of cableship is one designed for the purpose, but it is possible to convert certain merchant vessels when either



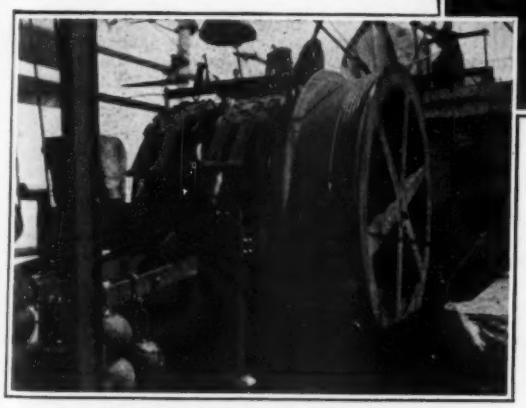
Two short lengths of cable syphon-recorder tape, showing how the telegraphic dots and dashes are received. Dots are above, dashes are below center line

time or money is limited. The primary requisite of a cable-laying steamship is to have several large circular tanks in the spaces ordinarily occupied by cargo holds; in these the cable is coiled and covered with water. A cableship ought to have ballast tanks of greater capacity than a cargo ship. A clipper bow is advantageous. On the bow are installed two or three large sheaves, over which the cable passes, and grapnel rope during repair operations. An essential feature of the equipment for cable repairs is a special form of powerful hoisting machine, usually having two drums of approximately six feet in diameter, around which the cable or rope is passed several times and is controlled in that way. The cable machinery is located according to the conformation of the vessel. On the "Burnside" it is on the main deck forward.

On the main deck there is a deep-sea sounding machine, and slung to the mast stays or lashed on deck there are a number of buoys of various sizes corresponding to ocean depths. Below decks will be found grapnel rope coiled in small tanks; quantities of iron sounding-shots, mushroom anchors needed to hold buoys in place, chains in assorted sizes, grapnel hooks of different kinds, spare parts, splicing material and plenty of rope.

To facilitate the landing of cable from ship to shore, the "Burnside" carried two steam launches and two cable cutters; these latter are small boats, but of wider beam and stronger construction than ordinary lifeboats. On the forecastle deck there are two dynamometers in line between the cable drums and the bow sheaves; these indicate the tension on cable or rope passing under them. Over the center of each tank is a bell-mouth and at various points over the decks are bell-mouths and rollers for guiding the moving cable in the desired direction. There is also a payout machine on the after main deck, for use in cable-laying operations only.

Deep-sea soundings are made by a special machine, perfected by Admiral Sigsbee and bearing his name. It consists of a small steam engine geared to a drum on which is wound a piano wire several miles in length without a splice. The wire in passing out operates a dial indicating the depth of water. On the lower end of the wire is attached a small brass tube having a hook for supporting a spherical iron weight, which has a hole through its diameter for the purpose of receiving the brass tube referred to. The heavy weight is very necessary in order to take the wire



Cable around drum of machine

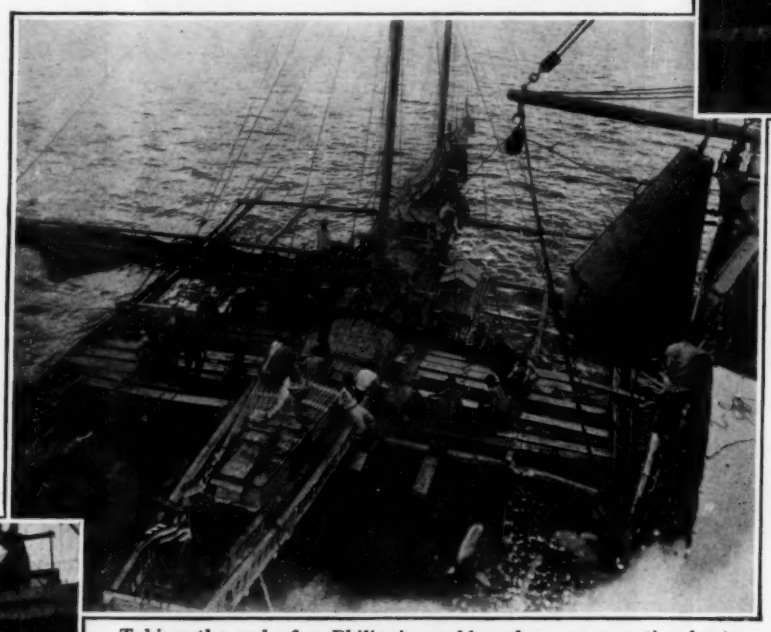
down to the bottom rapidly; otherwise ocean currents or drifting of the ship would allow the measuring wire to pay out at greater length than the true vertical distance to the bottom. As this tube strikes the ocean bed, the trip-hook releases the iron weight and at the same time the lower end of the tube picks up a sample of the mud or sand comprising the bottom. The loss of the iron weight permits the sounding wire to be pulled in rapidly without undue strain on it.

The floor of the ocean is surveyed first by soundings so that a route may be selected which will avoid laying the cable on the edge of a ledge, across a deep spot of small area, or over a submarine mountain. The cable is carefully coiled by hand in the tanks in flakes (flat layers) from the wall of the tank inward near the center cone. This facilitates the paying out at from 6 to 8 miles per hour. While the cable is passing out of the tank, it occasionally becomes tangled due to stickiness of the outer tar covering during warm weather. To meet such an emergency, an alarm bell is located on the navigating bridge with a contact button held by a petty officer who is constantly observing conditions in the tank. In case of a tangle, the ship's engines are reversed and usually in time to prevent the cable from parting.

For laying more than a short piece of cable, as in repair operations, it passes out over the stern. The cable is controlled by several turns of it being around the large drum of the pay-out machine which is well provided with powerful water-cooled brakes; these are adjustable so that the amount of tension may be regulated to correspond with the depth of water, the speed of the ship and the amount of slack desired. Between the pay-out machine and the stern sheave there is another dynamometer which at all times indicates the tension on the cable. The pay-out machine is equipped with a revolution counter which serves as an exact measure of the length of cable which has passed out.

While laying is in progress, the position of the ship is frequently determined and plotted by the navigating officers. The testing instruments remain connected to the cable so that in case the strain should produce a fault, it would be detected promptly.

The location of a fault in a cable involves only careful and accurate electrical measurements, but even to the most experienced cable electrician, certain kinds of faults present difficulties in accurate location. Knowing the electrical resistance per mile of the conductor, if there is a complete break with the copper exposed



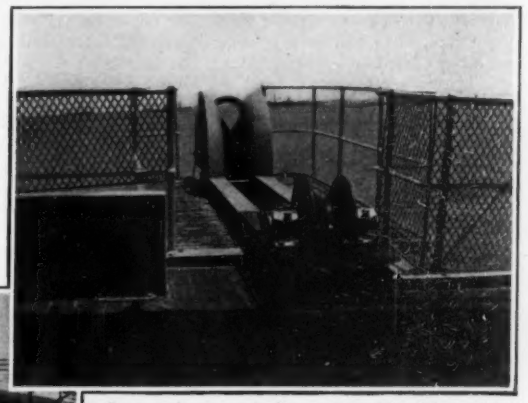
Taking the end of a Philippine cable ashore on a native boat

to the sea water, the measurement of the total resistance represents the number of miles to that fault. However, at times, only the conductor breaks inside the insulation so that an electrical circuit is not completed, in which case the electrostatic capacity and insulation-resistance measurements indicate the length of cable to the fault. It is the slight leakages of current which require more complicated and experienced testing, ordinarily from both ends of the faulty cable and with positive and negative polarities. Then applying a little algebra to the readings from both ends, the distance to the fault is determined remarkably close.

The cableship reaches the approximate position of a fault either by the usual astronomical observations or by dead reckoning when the sky is obscured. When sufficiently near shore, the ship's position is determined by angular bearings on prominent landmarks. The first action is to take a sounding as it is essential to know the depth of water; then a buoy is anchored on the assumed location of the cable, as a guide in the grappling operation.

The type of grapnel hook used depends upon the depth of water and nature of the sea bottom. There are various shapes to suit different conditions such as mud or rocky bottom. The rock grapnel has prongs which are capable of moving against a spring, and thereby release themselves if the end catches on a rock. Another special type is designed to cut the cable when caught, holding fast to one end and freeing the other. That is imperative for cables laid in very deep water, as it would not be possible to raise the cable to the surface intact without causing great tension, which probably would result in breaking it before reaching the surface. The grapnel of kind chosen is at the lower end of a flexible stranded steel rope made in sections which are shackled together. The length used is at least 40 per cent greater than the vertical depth of water so that the hook will be sure to drag along the bottom as the ship moves forward slowly, back and forth across the route of the cable.

By steadily increasing its reading the dynamometer under which the grapnel rope passes indicates that the cable is caught by the prongs of the grapnel. Rocky bottom causes sudden variations in the dynamometer indications. When there is plenty of slack or from depths of only a few hundred fathoms, the cable is drawn up above the surface; two other grapnel ropes are attached to the cable by stoppers on each side of the hook; next the cable is cut by a hacksaw between the stoppers. Then by heaving in on one rope and paying out on the other, each end of the cable may in



Stern sheave of the cable ship "Burnside"

turn be brought on board for electrical tests. The direction which proves to be good is then paid out again with a buoy attached to the upper end. The machinery then draws in the other cable which contains the fault. By leaving certain testing instruments connected while heaving in, it frequently happens that, as the fault comes above the surface, or as the cable is bent in passing over the bow sheaves, the sudden change in the electrical characteristics indicates that the fault is on board even if the tests did not locate the position accurately. The cable is now cut and tested shoreward; if clear of the fault, a splice is made to a new piece of cable which is then laid out to the buoyed end which first tested faultless. A second splice is then made; the bight is dropped overboard and the repair job is finished. In deep water the procedure is similar except that it is necessary to pick up the cable twice by grappling because the first time cuts and holds only one end.

An indiarubber joint is made by vulcanization with heat supplied either electrically or by boiling in paraffin, after which the jute and armor wires must be carefully laid on and then a seizing of spun-yarn over the entire length of five or six feet. At least one hour is required. A gutta-percha joint can be made more rapidly and easily by manipulating a hot iron, but the armor wire procedure is the same for both kinds of cable.

The conductor of the cable is separated from the sea water which completes the electrical circuit by only a small fraction of an inch. Therefore the electrostatic capacity of the cable is much greater than for the circuits of aerial land wires. The land lines are usually divided into separate short lengths by automatic repeaters every 500 miles or less, which is not practicable for cables. Consequently there is a lag or electrical drag in cable signaling which prevents the use of the sound reading instruments as universally employed in the United States for telegraph service. The retardation in long submarine cables is so great that the complete interruption followed by the flow of current in making signals at the sending end is not apparent as such at the receiving end. The cable acts as an electric condenser which is charged positively or negatively in combinations which form the telegraph code and at the receiving end can be read on recorder tape.

An ordinary telegraph relay would not respond to the extremely small amount of current which filters out at the far end of the condenser, perhaps three thousand miles away. The first receiving instruments employed on cables were very sensitive galvanometers which

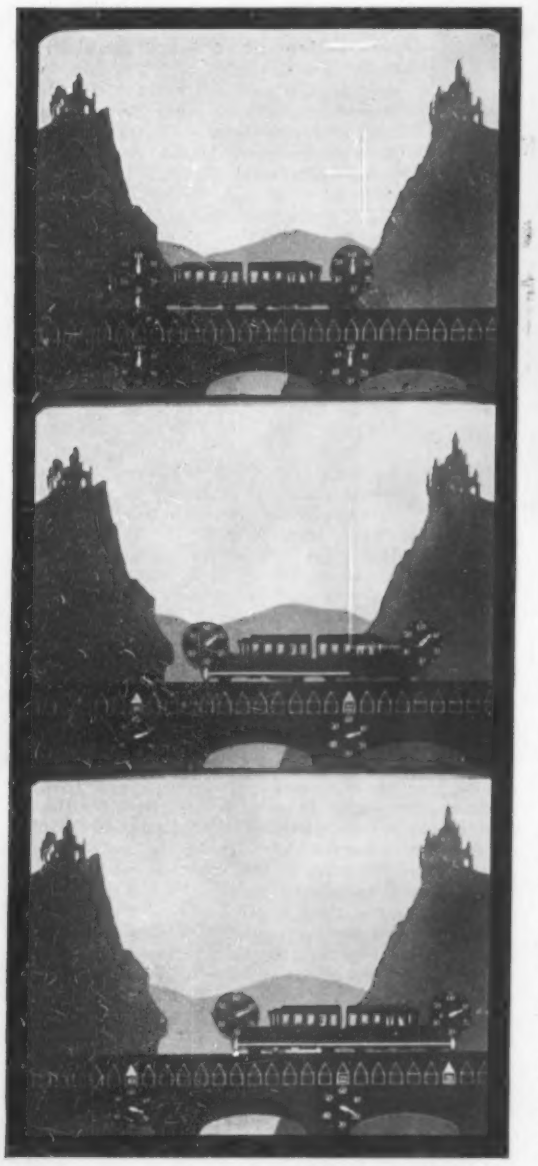
(Continued on page 142)

Relativity in the Films

By the Einstein Editor

DURING the period when the Einstein theories were acutely before the public, we were on numerous occasions asked whether we believed that an educational film could be got up presenting the relativity doctrines to the layman. We were in fact more than once asked to collaborate in the production of such a film. We replied always that we were inclined to doubt the possibility of the thing's being satisfactorily done. It is true that the usual explanations of relativity involve a large amount of diagrammatic work, and that some of these drawings might be animated to great advantage. But we have always been opposed to the excessive use of captions and explanatory text on the motion picture screen, and it has seemed to us that the Einstein pictures would be a very extreme case of this sort of thing; that they could be made intelligible, if at all, only by accompanying them with a volume of textual argument of book proportions. So we have always discouraged the would-be Einstein-film producer.

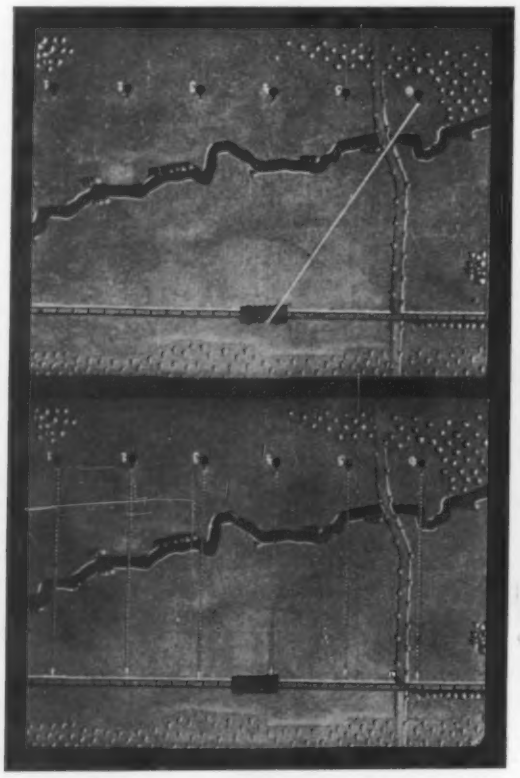
We are still of this opinion; but there is at least one person who disagrees with us and who is willing to back his opinion with real money. An Einstein film has been put out in Germany, and is reported to be received with sufficient favor to justify its existence. That this film has actually been prepared is evidenced by the strips from it which we show herewith; that it is actually meeting with success seems hardly possible. That it is not without its features of interest, however, especially to anyone who knows something about relativity, goes without saying. Of itself, it seems absurd to suppose that it can constitute a complete and convincing explanation; but as a supplement to an ordinary textual discussion of book, magazine, or lecture, it should be of great value.



The cinema version of the Einsteinian train that dashes through space at a speed comparing favorably with that of light, and exchanges signals between front and rear the while

As is always the case with arguments designed to make Einstein ideas appeal to the lay mind, the film consists in considerable part of more or less homely illustrations of the fact that things are not always as they seem, and do not even always seem the same. Thus we have the familiar case of the falling ball, which describes a straight-line path if the observer is traveling with the system from which it is dropped, and a parabolic one if he is isolated from that system. The point is usually illustrated by dropping a ball from the rear of a moving train; the present artist has instead dropped it from a tower which he attaches to a rather extensive piece of the earth's surface, while he puts his hypothetical detached observer off in space—in the audience, in other words. This particular scene seems very well worked out.

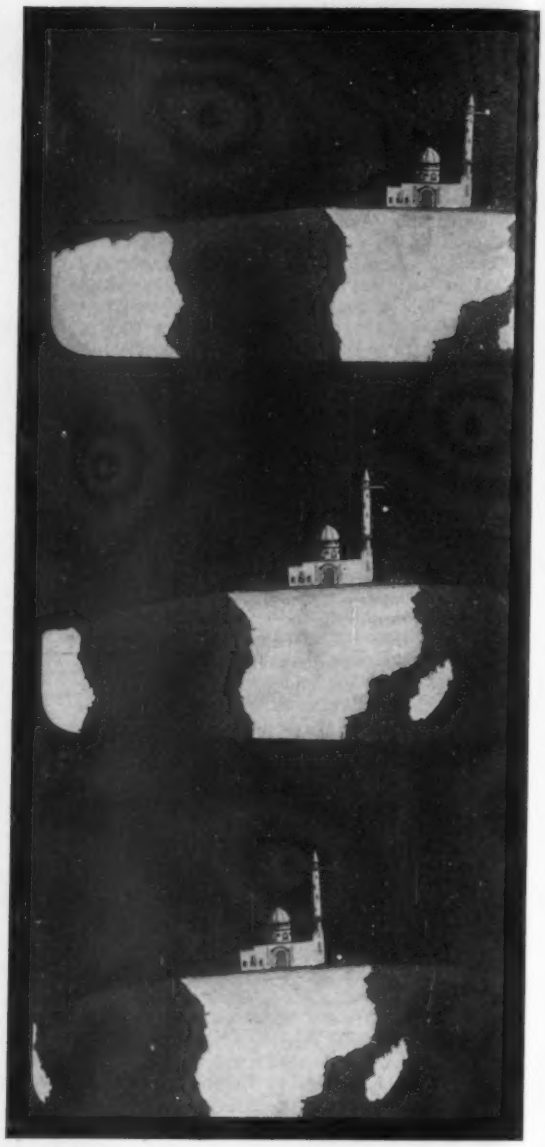
To start the Einstein argument with an elaborate illustration of the fact that a ship sailing around the earth presents a different appearance as it passes over the shoulder of the globe and out of the observer's field of vision seems rather trivial, but our film editor has not thought so. For this bit of mediocrity he



An original demonstration in connection with the Special Theory of Relativity, in which it is shown that one's knowledge of the state of motion existing between car and hedge affects one's interpretation of the results of the shooting

makes up with a further demonstration of every-day relativity which is new to us and which we suspect is original with him. He shows a row of soldiers shooting at a passing car, and calls the attention of the audience to the fact that the line of the bullet, if traced back from the two holes which it makes in the two sides of the car, will not point at the soldier from whose rifle the projectile came, but will point somewhere behind this man—perhaps actually at one of the other riflemen, whose shot went wild. This we recognize at once as a consequence of the relative motion between the riflemen and the car. The film goes on to show how the same effect would arise if the car were stationary and the marksmen being transported past it; and that, therefore, from merely noting this effect, the passengers on the car cannot really tell whether it is they or the ground that is moving.

When the film actually gets down to the relativity of Einstein, as distinct from that of ordinary experience, it appears to use the same old illustrations. We have the suspended cage in which the observer cannot distinguish between gravitation and mechanical acceleration; we have the train of amazing length moving across an endless viaduct and exchanging light signals with itself as it does so; we have, in fact, all the usual demonstrations. The animation of the drawings must add greatly to these, for one who has read and digested them; how lucid they would be to one who had not



What appears to be a straight line to the observer who travels with the tower and the earth is quite otherwise to an observer off "in space" among the audience. To his detached observation the ball travels in a parabola

read them and had only the brief time of the film's passage in which to digest them is problematical. We show a strip from one of the train experiments, in which the travel of a light signal is indicated by the white band along the bottom of the train. As in every case, the general style of this picture is very good; but we must criticize the director for having provided a material background. In the presence of this background, the phenomena shown may plausibly be referred to an observer at absolute rest beside the track, and the paradoxes and puzzles of relativity will disappear. As has been emphasized again and again, the whole Einstein argument in the Special Theory depends upon the fact that there is no adequate ground on which to say that, of two systems in relative motion, one is really in motion and the other really in a state of absolute rest. The background of rocks, etc., does not vitiate this condition for the scientist, but for the layman it is sure to do so.

We cannot pass from the subject without quoting the delightful efforts of the German caption writer to make the pictures of the film more salable in this country by supplying data about them in English. In some cases he gets away with this fairly well. In others—well, to say the least, he reveals his own nationality. For instance: "The removed train of Prof. Einstein. By light and time measuring it is demonstrated on this train, which is passing a viaduct, that equally to the measures of space also the measures of time in a system moved nearly as quickly as light, do not correspondent in the least which the measures taken out of this system." We can now agree with him that "As the puzzles of this railroad six millions kilometers will hardly be intelligible to our readers, once will understand that it takes at least a film to get an idea of it."

Left: External view of the eighty-foot tube. *Right:* After the day's tests are completed, the motor and the open end of the tunnel are covered with a huge canvas

Two views of Uncle Sam's new outdoor wind tunnel

A New Outdoor Wind Tunnel

A NEW wind tunnel has recently been built outdoors at the U. S. Bureau of Standards where it will be used in solving many of the problems of aerial navigation and airplane construction. It is the largest test tunnel of its type in the country, and, for that matter, in the world, as the biggest English testing tunnels are rectangular in shape with the cross section 7 feet each way. Two of these rectangular tunnels have been built side by side with a removable wall between so that they can be converted into one large rectangular vault. The new wind tunnel built by Uncle Sam consists of two sections. One section is 10 feet in diameter and 50 feet long while the other which serves as an exit cone is 30 feet long and 14 feet in diameter at its outer end. The wind pressure is provided by a four-blade propeller that is 14 feet long. This propeller is driven by a 200-horsepower motor which for short periods can be overloaded to develop 250 horsepower. The maximum rate of revolution of the propeller will be about 600 per minute.

Hitherto, the Bureau of Standards has been using two indoor test tunnels in its airplane research investigations. The largest of these interior tunnels is 54 inches across and is octagonal in shape. Its total length is 45 feet. It gets its wind power from a four-bladed propeller 9 feet long which is run by a 100 horsepower motor. In this test tunnel, wind velocities ranging between 85 and 90 miles an hour have been developed and much important scientific and technical data have been collected both for the U. S. Air Service and commercial enterprises. A smaller cylindrical high-speed tunnel which is 50 feet long and 3 feet in diameter has also been used successfully. Very high wind velocities amounting to as much as 125 to 150 miles an hour—three times as swift as many of our tornado and cyclonic disturbances—have been produced in this novel scientific cylinder. A seven foot propeller with 8 blades is run by a 100-horsepower motor. In the wind tunnel experiments, heavy motors are required to produce the excessive wind velocities. This obtains from the fact that in order to double the speed of the wind, it is necessary to use eight times as much power.

The new wind tunnel which will soon be put to work will be devoted initially to the solution of problems associated with airship resistance. Different kinds of airship rigging and wings and different sizes and shapes of airplanes will be experimented with to ascertain those that are most satisfactory from the angle of offering the minimum resistance and frictional losses as they whiz through the upper air. The new tunnel also permits of testing out the larger types of airships which are now becoming popular. In fact one of the reasons that it was built was because the popular trend has been towards the perfection of larger airships which were entirely too large to be tested out in the smaller indoor tunnels. The new tunnel was built outdoors to save money as, otherwise, a special building would have to be built to shelter this aircraft testing laboratory. The outdoor wind may exert some deleterious effects on the delicate experiments during windy weather but, as far as possible, the experts in charge of these investigations intend to confine their experiments to calm days when the wind can not exert any evil influences on the scientific data. It is not believed that Washington winds are severe enough to be a serious embarrassment.

Gage for Oil Dilution

AN instrument for determining the dilution of crank-case oil has been recently placed on the market. It is in the form of a hydrometer, on the stem of which there is a sliding tube with scale marks lettered: "Danger," "Poor," "Fair," and "Good." The sleeve is set so that new oil will show "Good," and the scale mark to which the instrument submerges then indicates the degree of dilution. Tables for different oils have been worked out for the use of the operator.

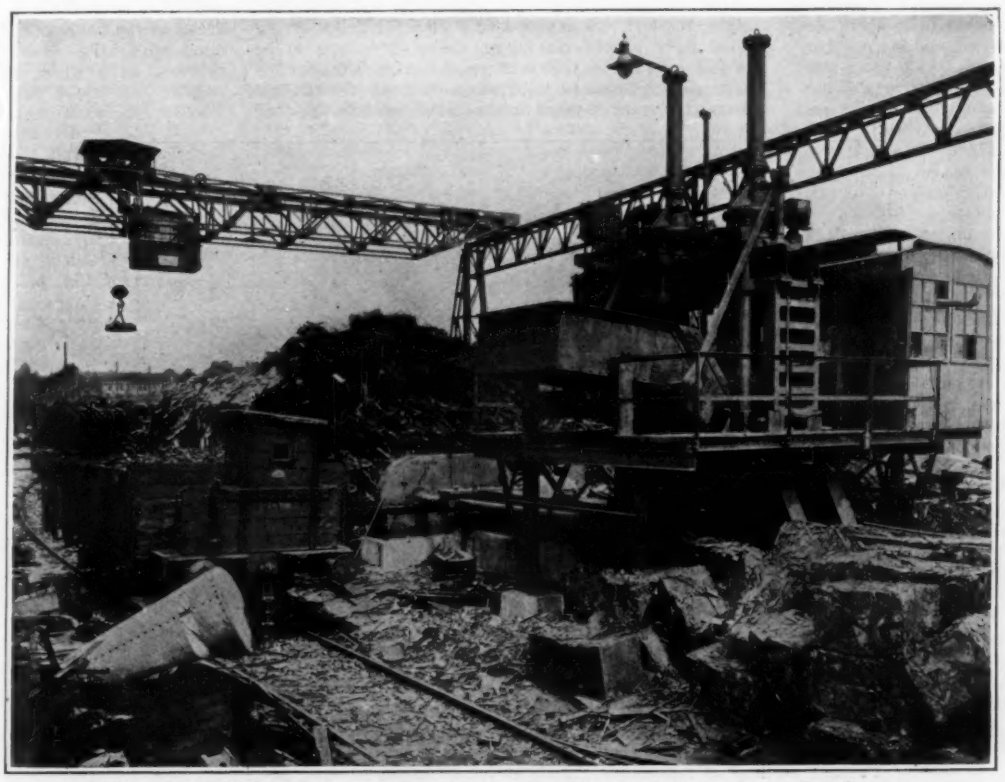
An Electric Press for Scrap Metal

THE high price today of old metal compels every effort to utilize scrap of every description. Not alone must the better grade be melted, the grade that comes in single pieces of reasonable weight; but the very lowest grade of scrap must also be conserved. This is available only in pieces whose bulk is out of all proportion to their weight—large, twisted sheets, tangles of wire, etc., etc. It is possible to handle such material in the furnace only after it has been pressed and bundled so that a single melting will include an adequate weight of metal.

Nowhere is this situation more acute than in Germany. Even in former times, the attempt to do the necessary handling by hand or with the aid of a drop hammer was of doubtful profit; with the higher wages of today it would be utterly out of the question to handle the stuff this way. Hydraulic presses have been tried, but are found unduly expensive as regards both installation and operation. This leaves the field to the electric press, and we illustrate such a one.

The construction is simple enough. There is a trough-shaped box or chamber in which the pressing is carried out; there are guides at the side connected by a cross-head; and there is a horizontal and a vertical ram. The scrap is loaded by lifting magnet direct from the cars into the big receiver shown, which tilts its contents in the press chamber. A motor located on the cross-head drives, with appropriate gear-reduction, two vertical screws. As the ram is forced down against the contents of the chamber, it meets resistance, and the further it goes the greater the amperage necessary to drive it. A cut-out is arranged that throws the current off when the amperage reaches a predetermined figure, thus regulating automatically the density of the bale of pressed metal. The vertical ram is then held in the place to which it has been driven, while the horizontal ram comes into play and compresses the material in the other direction. In this way a clean, smooth bundle is obtained, which does not have to be trimmed. The rams then return to their initial position, and the filling bucket comes into play again. The cycle is repeated until the bale has grown to the desired size, whereupon the horizontal ram makes one more stroke, this time unopposed by any back-stop, and sweeps the finished bale out of the chamber.

The presses of this design are made in three sizes. According to the size, the daily capacity (eight hours) is from 20 to 70 metric tons of 2200 pounds each.

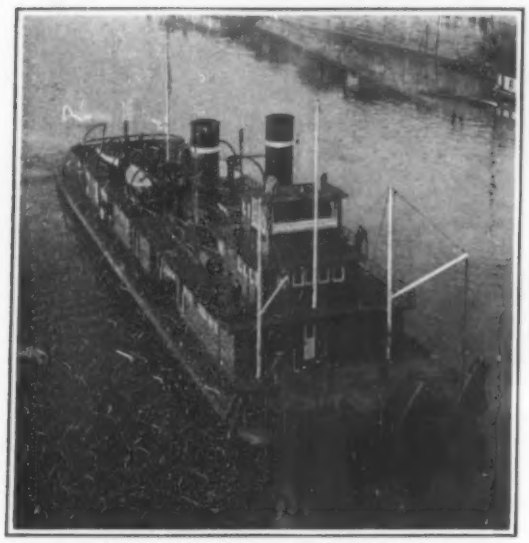


Making large, light metal scrap available for remelting by baling it in an electric press

A New Era in Transportation

A Proposed 1100-Mile System of Train Ferriage on the Father of Waters

By Samuel W. Allender



One of the new Government-built towboats—powerful steel vessels, with 2500-horsepower engines and propeller operating in a tunnel

FIFTY or sixty years ago the principal means of transportation in the Mississippi Valley was the river navigation. In 1852, when "steamboating on the Mississippi" was at its height, 3149 steamboats docked at Saint Louis. This method of transportation was highly picturesque, but low in efficiency; and while it furnished the material for Mark Twain and "Jim Bledsoe" the carrying capacity of the steamboats in Mark Twain's time averaged about 30 tons each. Then came the steam railroads, and because of their more modern equipment and methods, the old steamboats disappeared from the river, and the steam railroads became practically the sole means of transportation—a development which Mark Twain himself lived to see and to describe in "Life on the Mississippi." But about four years ago was started a revival of river transportation, and because modern methods are being employed, it is being demonstrated that, in spite of the verdict of the '70's, river navigation is practicable and economical in the transportation of freight.

The United States Government inaugurated a Barge Line, as a war measure, to aid the railroad congestion during the war. This line has continued in operation, and is today doing a capacity business, making a saving to shippers of 20 per cent under the rail rates, and actually operating at a profit. The motive power consists of tunnel-type towboats, burning oil for fuel and propelled by a screw propeller instead of a stern wheel, equipped with wireless, and capable of towing 8 or 10 steel barges loaded with 15,000 tons of freight. Modern docks have been built at the principal cities on the river, and others are under construction. The Barge Line operating between Saint Louis and New Orleans publishes through rail-and-water freight rates to points hundreds of miles from the river, and by interchanging freight with the railroads, gives the benefit of the saving in the rates to points great distances from the river. The 20 per cent saving in the freight rate is attracting more business than the Barge Line is equipped to handle.

With the methods now in use by the Barge Line, there are fundamental obstacles preventing the full utilization, and the greatest economy of water transportation. The most important of these drawbacks in the present system is the inability to transport freight in bulk, with the single exception of grain. Grain is accepted because there are several grain elevators on the river bank at the water's edge, which are able to load and unload barges with grain economically. All other bulk freight such as usually loads in bulk in freight-cars—brick, lumber, sulfur, salt, etc.—cannot be handled, and only freight in packages, barrels, boxes, bales, etc., can be accepted for shipment. Since the industries are located on railroads away from the river bank, practically all the freight handled by the Barge Line must be transferred to and from freight cars, and the cost of this re-handling of the freight from cars to barge and from barge to cars, would be prohibitive in the handling of freight loaded in bulk, in freight cars. This re-handling cost on the package freight now transported by the Barge Line is very high, and the cost of loading and transferring the freight from the cars to the barge, and from the barge to the cars, is greater than the cost of towing the freight from New Orleans to Saint Louis. Since there has been no river transportation for nearly 50 years, the industries have located on railroad tracks, away from the river's edge, and therefore there are practically no industries located on this 1100 mile transportation line, necessitating the transferring of practically all freight to and from freight cars. In addition to this high cost of transferring freight to and from freight cars, there is great delay in this re-handling of freight; it taking days to load and unload a single tow of barges, even when the only freight handled is the more easily handled package freight.

Also, this double re-handling causes loss and damage to the freight, making the claims for loss and damage an expensive item, and some fragile articles cannot be accepted even when in packages.

In the annual report of the Secretary of War, for the year ending June 30, 1921, is included a report by Colonel T. Q. Ashburn, Director of Transportation, in which Colonel Ashburn states: "The sore need of reducing the cost of transferring freight from barge to car, and vice versa, is manifest, and 39c out of every dollar for freight charges is paid out for terminal charges; and that it actually costs 4c per ton more to load freight on the barge at Saint Louis and unload it at New Orleans, than it does to haul it the 1142 miles of river stretching between the two cities. Moreover, the losses and damage to freight, caused almost entirely by the present methods of loading and unloading, have reached the forbidding figure of 18c for every ton of freight hauled, amounting to 4c out of every dollar earned. When it is taken into account that the railroads of the United States—and it is with the railroads that this Barge Line comes into active competition—suffer in loss and damage to freight only 4½c per ton transported, or about 2½c out of every dollar earned, the necessity for modern river and rail terminals becomes all the more impressive."

To overcome this limitation and costly re-handling of freight, the writer has proposed a plan for transporting loaded freight cars via barge, these car-barges to be 300 feet long by 50 feet wide, and having 3 tracks for 21 freight cars on deck, with adequate space for hatches between the tracks—these hatches to be used for loading

Present method of unloading barges. This labor would be eliminated by loading railroad cars, intact, on to barges

grain, liquid cargo or any other freight below deck. Each towboat would tow 8 or 10 of these barges, each barge containing 21 loaded cars, just as 8 or 10 barges are towed at present. After loading freight below deck, the loaded freight cars would be run on to the barge by a railroad switch engine. It would be advantageous to load grain below deck on the southbound trips, as there is an immense tonnage of grain seeking the river route; and on the northbound trips it would be advantageous to load such import commodities as move in barge-load lots, direct from ship side, such as jute, coffee, nitrates, etc. The loaded freight cars would be switched to the deck of the barge by the use of loading tracks or "cradles," just as are now in use at many points on the river for transferring cars across the river by the use of car ferries. In fact the plan is simply an enlargement of the car ferry idea—instead of a self-propelled ferry boat, loaded only with freight cars, crossing from shore to shore, we would have a powerful towboat towing a flock of 8 or 10 barges loaded with many thousand tons of freight below deck, and with several trains of loaded freight cars on the decks of the barges, making trips of over one thousand miles each. To visualize the plan; we would have a railroad, as it were, operating trains on a ready built roadbed of water, the locomotive being a powerful towboat drawing a train loaded with freight, the equivalent of 15 or 20 "dry land" freight trains.

Present method of transferring freight from barges to cars, at the Municipal Dock, St. Louis, Missouri

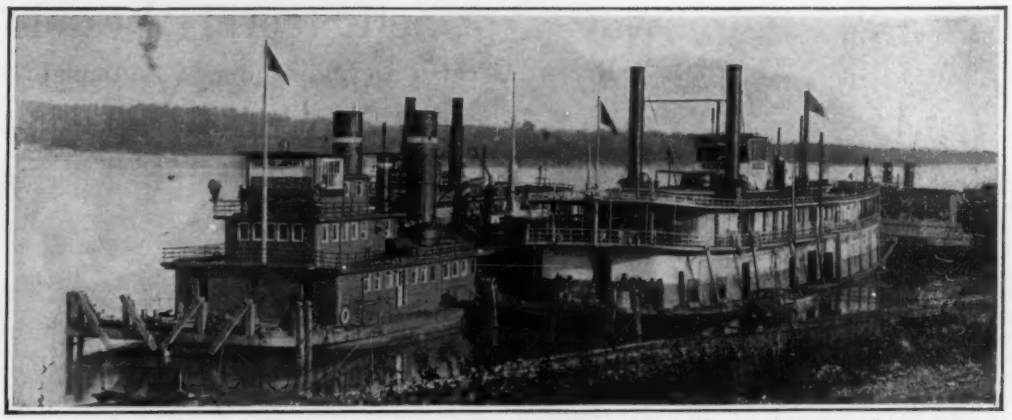
Freight cars are interchanged between the railroads, and could be so exchanged with the Barge Line, as it is a common carrier, under the jurisdiction of the Interstate Commerce Commission, just as is any railroad. The Barge Line would pay $1.00 per day ("per diem") for the use of the car, to the railroad owning the car, just as all railroads now pay rental to other roads for use of "foreign" cars while on their rails. If necessary for the Barge Line to own its own railroad freight cars, it could do so at considerably less expense than the cost of any one of the docks now required.

The objection might be advanced that the dead, or tare weight of the cars carried, would make the plan impracticable. In the first place, the railroads carry the dead weight of cars and wear the cars out while doing it. The Barge Line can probably tow the dead weight of the cars for less than 50 per cent of the cost to the railroad to pull the dead weight of the cars. The cost of repairs to the cars would be eliminated, as there would be no wear and tear to the cars while on the barges. Even if this were an objection, certainly the advantages of the plan would more than offset this objection.

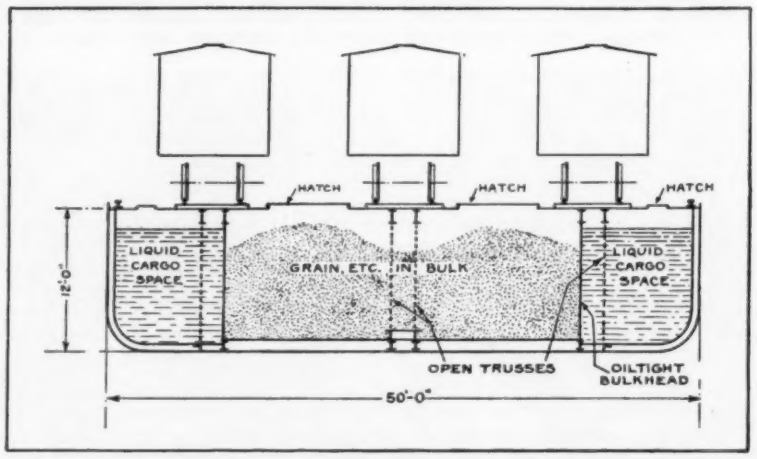
The saving in freight charges to the shippers of bulk commodities, not enjoying the use of the Barge Line at present, would be enormous. For instance: sulfur is produced in enormous quantities at mines in Louisiana, and shipped to northern points, in bulk in cars. The rail rate on sulfur from the mines to Saint Louis is $8.80 per ton, and since 50 tons are loaded in a freight car, the freight on a car of sulfur of 50 tons is $440.00. Sulfur in bulk cannot be accepted by the Barge Line, but if it were able to handle sulfur in bulk at a 20 per cent differential under the rail rate, the saving to sulfuric acid producers would be $88.00 per car. Also on heavy tonnage commodities the differential need not be as great as 20 per cent. In fact a 5 per cent differential would attract all such commodities to the water route, as the heavy tonnage shippers of bulk commodities could not afford not to make a 5 per cent saving in freight on such commodities. The 5 per cent saving would be more attractive to the slow-going heavy bulk freight shipments, than is the 20 per cent saving to the higher class merchandise freight usually shipped in packages, for time is the more important factor on the merchandise package freight, while cost is the important factor in the transportation of low-grade bulk commodities.

Also a great saving would be made in the operation of the Barge Line, in that the Barge Line would not require as many expensive docks; the cost of loading freight cars on to the barges would be practically nil—the loading being a matter of minutes for a switch engine to run the cars on to the barges. Also the Barge Line would save the heavy claim account for loss and damage, and the saving in the time required for loading would be an important improvement in the present method.

The Barge Line would then enjoy the utility of the railway and retain the economy of waterway transportation, permitting the Barge Line to transport bulk freight in freight cars from industry to industry, without touching the freight in the car and without breaking the car seal.



The old-type, stern wheel towboat "Ginger Bread" in the center, with a modern tunnel-type, screw propeller alongside



Cross-section of one of the proposed barges for transporting loaded cars between St. Louis and New Orleans, thereby saving the big labor cost of loading and unloading from car to barge and barge to car. Capacity: twenty-one 40-ton cars, and 1200 tons of grain and oil in the hold

Corrosion of Chrome Steels

TESTS of the resistance of chromium steels to acid corrosion have recently been completed, and a comparison of the results obtained shows that the relative resistance of a steel to the acid test is not necessarily a criterion of its behavior in other types of corrosion. Pure iron and the steels of low chromium content were found to be much more resistant to attack by hydrochloric acid than those containing considerable chromium. When corroded by water and air, the general order of resistance was reversed. It may be concluded, then, that the addition of chromium increases the rate of attack by hydrochloric and probably by other acids, although this may depend somewhat on the heat treatment which the steel has received. Specimens which had been hardened by suitable heat treatment were found to be considerably more resistant to acid attack than samples of the same composition in the annealed state. The addition of nickel is much more effective in reducing the intensity of the attack by acid than is chromium, since steels containing a considerable amount of this metal were found to be the most resistant to acid of all those examined with reference to this property.

For resisting corrosion by water and air, a considerable amount of chromium in a steel is necessary, and alloys of this general type are found much more resistant than those of low chromium content. These latter steels, however, are more resistant than the simple carbon steel or "pure" iron. Hardening the chromium steel by heat treatment retards erosion by water and air. This is true, in particular, for the steels of high chromium content, while variations in heat treatment produce very little difference in resistance to corrosion in specimens lower in chromium. Adhering patches of oxide scale upon the surface have a very noticeable effect in accelerating the rate of attack of the chromium steels.

The alloy containing a high percentage of nickel, as well as chromium, found to be attacked the least by acid, also proves much more resistant to atmospheric corrosion than most of the chromium steels, although far surpassed by certain of the high-chromium materials.

In most cases corrosion of the chromium steels consists in an attack at small isolated spots rather than in a general tarnishing and coating of the surface. This, in view of the fact that adhering particles of scale accelerate the corrosive attack of a steel to a very marked degree, suggests that the presence of inclusions or other defects within the material may be responsible in large measure for the character of the resulting surface pattern.

A tow of 15,000 tons on the Mississippi. One of these towboats could handle five of the new barges of the type shown in the center illustration

From Iron Ore to Automobile in Ore Plant

FROM the iron in iron ore to the automobile direct may seem a dream of impossible accomplishment and startling too, but there are reasonable prospects of its fulfilment. One of the largest motor companies is back of such a scheme. The facts are as follows:

Within the last two or three years the company built two large blast furnaces in which it is making its own pig iron from iron ore. For some time this company has been making its own iron castings from this pig iron, using the iron hot as it comes from the furnaces. This procedure obviates the expense and delay involved in remelting the pig iron in cupolas before pouring it into castings. It was thought originally that the cupola could be entirely eliminated and the pig iron cast at once into molds, but experimental working has shown that this cannot be done. Therefore the practice has been adopted of taking a large part of the metal direct from the blast furnace and mixing with it a definite proportion of remelted iron from the cupolas.

Since these developments the original scheme has been considerably expanded, and if present plans are carried out the motor company will have the largest electric steel plant in the world. The company has already purchased several electric steel furnaces and when the entire number are installed there will be 12 to 15 such furnaces. The hot pig iron from the blast furnaces will not only be converted into iron castings for automobiles, but this electric process will transform the iron into steel for steel castings and for steel for other forms which help to make up the modern flivver.

When this scheme is fully carried out it will present a wonderful achievement and it can be truly said that this expression "From iron ore to automobile direct" represents one of the most interesting developments ever recorded.

Locomotive Testing With a Piano

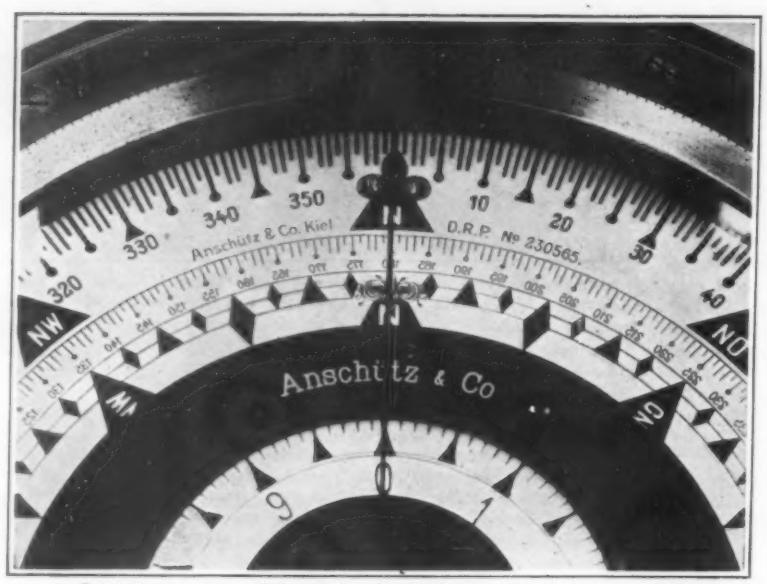
A PIANO seems to be out of place in a locomotive workshop, yet it has been found to play a very useful part. There is no better way of discovering cracks and defects in the different parts of the machinery than by striking the metal with a hammer and then comparing the noise of the vibrations with the piano notes. The man operating the piano must have a trained ear for music, seeing that it is his business to listen for the slightest discords. If the metal rings harmoniously with the piano note all is well; the least flaw will result in a discord. Defects that are hardly to be noticed by the ordinary method of hammering are at once evident when the piano test is employed. A locomotive that rings true all over, each note which it yields synchronizing properly with the same note as given by the piano, is certainly fit to take its place in service on the railway.

Self-Steering Vessels

Recent German Developments in Automatic Gyro Practice

By Dr. Alfred Gradenwitz

A PROBLEM which for about ten years had been the order of the day has recently found its solution in the trial trip of the Danish S.S. "Konig Frederik VIII," equipped with a self-steering Anschütz gyro compass. It will be remembered that Dr. Anschütz-Kaempfe, who at the beginning of this century was making plans for a North Pole submarine expedition, eventually developed a gyroscopic compass of remarkable efficiency and simplicity which during the war was in general use with the German navy, as well as on a great many merchant ships. This compass will, of its own accord and with great energy, place its axle in the meridian line, remaining in this position of equilibrium, pointing due north without any oscillations. The gyroscopic compass can, of course, be placed in any part of the ship, its readings being interfered with by no rolling or other movement of the latter. Owing to its floating suspension in a mercury bath, friction is reduced to a minimum and the readings are practically instantaneous without any lag. From the master compass they are transmitted electrically to as many receivers as required. Each of these comprises an inner or minute dial, a complete revolution of which corresponds to a change of 10° in the course of the ship, thus allowing tenths of a degree to be read easily and exactly. This inner dial is of the greatest advantage for steering: the immediate and most accurate indication of the least yaw of the ship enabling the helmsman to keep it on a perfectly straight course.



Compass receiver dials, with minute dial inside the degree dial

The same result is with even greater accuracy and a great saving of energy attained by the self-steering compass installed on board the "Konig Frederik VIII," where a Compass Receiver is relied upon to keep the ship on the prescribed course. The apparatus is the outcome of numerous tests and extensive experience in connection with the automatic steering of unmanned fast boats.

The task otherwise entrusted to the helmsman, viz., watching the compass and compensating any deflection from the course by a proper rotation of the steering wheel, is here performed mechanically by a small electric motor steered immediately from a compass receiver.

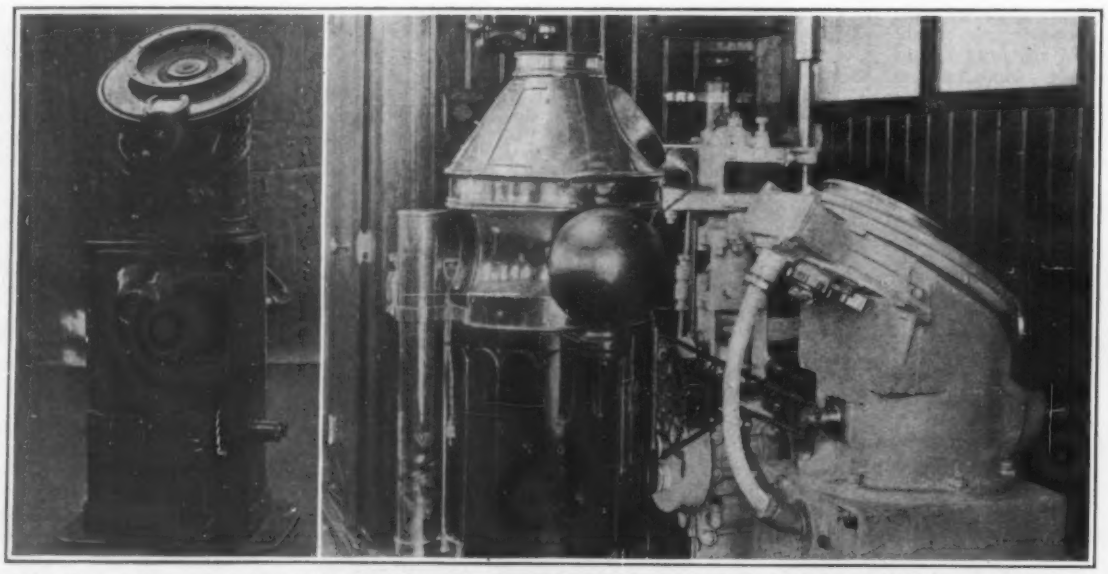
This compass receiver, in fact, comprises a contact which, on the least rotation of the ship, closes the circuit of a relay, which in turn closes the circuit of the electro-motor arranged in the lower part of the self-steering outfit. A toothed wheel on the axle of the electro-motor is by a toothed chain connected with a toothed wheel on the axle of the steering wheel, thus communicating its own rotation to the latter.

A clutch lever acting on the toothed chain allows the self-steering outfit to be thrown in and out at will. After making sure that the readings of the compass receiver agree with those of the master compass, the current actuating the steering motor is completed. After another half-minute, the operator, by consulting the same compass receiver, ascertains whether the ship accurately keeps the course marked by the compass. As soon as the rudder gage of the steering outfit marks "amidships," the clutch lever is thrown in, thus causing the ship automatically to keep the course adjusted for. Whenever the course is to be changed, a small adjusting wheel (visible in the first photograph immediately below the minute dial) is operated, a full rotation of which results in an automatic change of 10° in the course of the ship. The graduation of the wheel rim enables any change of the course to be effected with remarkable accuracy.

A simple manipulation thus suffices to alter the course of the ship. In urgent cases, however, the pilot may as well seize hold of the steering wheel, thus avoiding any loss of time and any chance of error due to the transmission of orders. This possibility is of immense advantage in rough weather and greatly adds to the maneuvering capacity of the ship, automatic steering being resumed immediately on releasing the lever.

Inasmuch as the rotation of the steering wheel instantaneously follows on any deflection of the ship, the rudder mechanism, as a matter of fact, is only operated to a very slight extent, the ship being kept on a remarkably straight course, so that the line in the wake, in a quiet sea, extends quite straight over the surface of the water. This, however, greatly reduces expenses and augments the traveling speed. The advantages afforded by automatic steering are especially conspicuous in rough weather, even the best helmsman, in the case of marked rolling, losing a great deal of his customary efficiency of steering.

The trial trips above referred to have given most satisfactory results, already the first apparatus having in good weather allowed the course to be maintained within 0.4 degree. Automatic steering in rough weather is decidedly superior to the performance of even the most skilled helmsman. The master compass can, of course, be installed anywhere in the ship, provided it be sheltered from the wind and weather; while the compass receiver, being weather-proof, can be placed at any place and in any position desired.



Left: Above, the compass receiver dial; beneath, the rudder gage; then the course-change wheel; finally the clutch lever controlling the automatic steering device. *Right:* The dispositions in the steering cabin, giving a back view of the rudder stand of the previous photograph, and showing how this communicates by toothed chain with the tele-motor of the steering mechanism. These views are from different steamers and hence do not agree in every detail

The control mechanism of the automatic steering system

Permeability

IN the study of the living organism there presents itself a well-marked group of problems arising from phenomena which can be included under the term "Permeability." Every organism receives from its environment in some form or another substances which enter into its body and which either as such or after undergoing physical and chemical change and working up into new combinations, may be carried to every part of the organism. The problems concerned in this intake into the organism of substances from the surroundings, and their passage out from the cell into the external medium, and the translocation of substances from cell to cell in the body of the organism, may be spoken of broadly as problems of permeability.

The problem is, then, to discover the laws governing the penetration of substances into and through the living cell. It is obvious that it is of first importance to understand the system involved.

We have to think of protoplasm not merely as an intimate mixture of a large number of substances, but as having a complex organization so that the cell is rather an organ with an intricate minute structure, and at the same time different reactions can take place in different parts of the same cell. "Protoplasm is an extraordinarily complex heterogeneous system of numerous phases and components, continually changing their relations under the influence of electrolytes and other agents."

This system is very varied, attaining a high complexity in the adult plant cell. In the latter we have to recognize at least three phases, the cell wall, the protoplasm and the vacuole. Each of these, moreover, is itself a complex system, both the cell wall and protoplasm each containing a more watery phase and at least one other phase, while there is evidence that the cell, say, in the vacuole may also contain a colloidal disperse phase as well as water with substances in pure solution. At the boundaries between outer medium and cell wall, cell wall and protoplasm, protoplasm and vacuole, there are separating layers which there is every reason to believe have different properties from the bulk of the phases they separate. Further, in both the cell wall and protoplasm, and perhaps also in the vacuole, we have at least two-phase and probably polyphase systems in which there are consequently relatively large surfaces of contact between the phases. On this showing, the problem of permeability becomes obviously the fundamental one of cell economics and metabolism in general. — Abstract from the *New Phytologist* (London), June, 1921, article by Walter Stiles.

The Rolling Dump that Uses No Power

ORIGINALLY the practice in the modern tipple was to employ a cross-over dump that requires a hinged door on the front end of the cars, which are then emptied by tilting them endways. The objections to this construction are many. The loose-end car is naturally weaker and requires extensive repairs; there is excessive waste and breakage of coal; slack or wet coal sticks and requires additional labor to trim the cars clean; at the best two men are necessary in the operation of the dump; and wear and tear on dump and cars is heavy.

As a result of these conditions, the solid car-revolving dump was designed. But while this relieves all the difficulties mentioned except that of breakage, it introduces a fresh crop of its own. Power is necessary for its operation; it is difficult to spot the cars and to discharge from the dump; there is no saving in labor, and operation is not automatic.

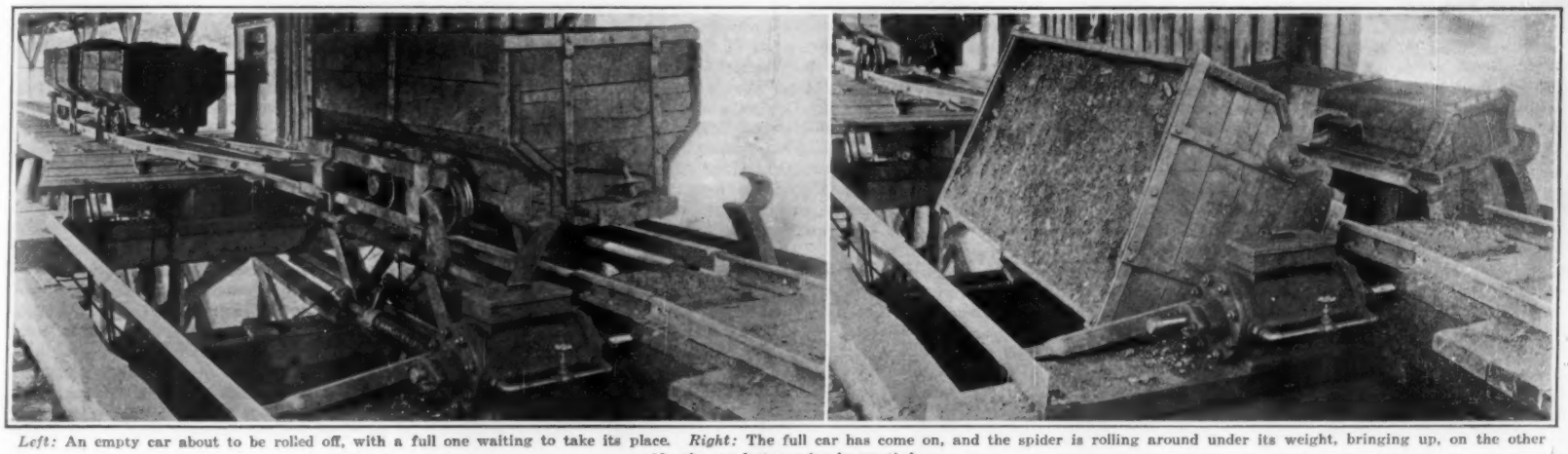
The empty dump with the right-hand side of the spider up, showing the degree to which it is off center on its shaft

All ordinary dumps are constructed to revolve through angles of 180 or 360 degrees. The effort to eliminate the drawbacks just catalogued has led to the design of a dump which differs radically from the revolving dumps heretofore seen. It has two tracks, mounted on the arms of a complicated spider in such a way that their planes make an angle of 130 degrees. When one of these tracks is up, and in line with the entering and leaving track, the other is, of course, down at one side or the other. The great trick comes in the construction of the spider in such a way that, whichever track is up, this track is off center with reference to the spindle at the center of the spider. Our first view shows the right-hand track up, and it will be seen that it is well off center to the right of the shaft about which it revolves. When it goes down (to the right) and brings the left-hand track up, this one is equally off center to the left.

With this arrangement, operation is automatic and consumes no power. With the dump in the position of this first view, a loaded car is run on, and locked in place on the spider. The latter is then released, and the weight of the car, in view of its eccentric position on the spider, is sufficient to swing it over to the right and down. Heavy oil-immersed pistons counterweight this swing, preventing it from becoming too swift or going too far; and when the travel is gently checked at its extreme point, the car dumps itself without further attention.

The spider is now locked in this position while a second loaded car is run on. Again, when the spider is released, the purchase which its off-center position gives it is sufficient to enable this car to swing over, to the left, this time, into dumping position, carrying the empty car up at the right. And so on, all day. No power is used, no trimming out of the cars is necessary—everything runs smoothly and automatically along.

Of course, in its engineering details there is more to the dump than this very simple outline might indicate. For our purposes this general indication of the cycle of operation is adequate, however. But it must not be supposed that because we pass them over, the engineering details are crudely worked out.



Left: An empty car about to be rolled off, with a full one waiting to take its place. *Right:* The full car has come on, and the spider is rolling around under its weight, bringing up, on the other side, the car last previously emptied

The operation of the dump in which the loaded car's weight carries it down into dumping position and brings up the empty car

Poor Wiring a Common Automobile Fault

ONE prolific source of trouble in many makes of cars today is due to poorly laid out and carelessly executed jobs of wiring for the electrical units. Grounds, short circuits and loose connections may occur at times in the highest grade cars, but they are much more frequent where the work is indifferently done. In general, wiring should be inclosed, but still left as accessible as possible. In every case it should be well supported to prevent abrasion from vibration, and so located as to be protected from oil and other media.

A New Job for the Jitney

IN the great Dismal Swamp of eastern Virginia and North Carolina, one of the lumber companies has recently inaugurated a new means of switching log cars in the woods. This invention consists of a small automobile of a popular make, either a touring or roadster chassis, mounted on a specially constructed truck. The outfit is well illustrated in the accompanying photograph. Special sprocket wheels are attached to both of the two axles connecting the car wheels and to the rear axle of the automobile. This type of locomotive is capable of attaining a speed of 35 to 40 miles per hour when running as a passenger-carrying conveyance on the main line logging railroad, or, by attaching smaller sprockets to the automobile axle it can be geared down to a speed of 5 to 10 miles per hour with increased tractive power. Provision is also made for connecting with a sprocket chain both of the large axles, enabling the flanged car wheels to secure greater traction. Through an ingenious device, the upper frame to which the automobile is clamped is pivoted to the center of the lower frame and held securely by two large set screws at the rear end of the upper frame. This arrangement permits the locomotive's being turned around without moving the heavy lower frame or switching it on to a Y-track.

This type of locomotive has several pronounced advantages over the usual logging engine. Probably the most important of these is the elimination of the fire hazard which is a very serious factor in the highly inflammable southern white cedar slash. The use of gasoline with the consequent absence of the sparks which are habitually thrown about by the ordinary wood-burning logging engine puts an end to this danger, and thereby eliminates the greatest single factor of loss to which the lumbering industry is exposed. Furthermore, the jitney engine has a lower cost of maintenance than a regular engine, and the logs can therefore be delivered more economically to the main line where the cars are made up into a train pulled by a larger locomotive.

A special sprocket-wheel gear enables the "flivver" to act as a logging engine

The auto-locomotive can be operated more successfully than the regular type on cheaply constructed spurs having unusually rough roadbeds and sharp curves, and lighter rails can also be used on these spurs. It is capable of switching in one load three to five cars of logs from the spurs to the main line. It is, of course, not suited and not intended for use on the main line with long trains, but for work where the cutting is actually going on it is unsurpassed.

The Development of Accurate Ammunition

Rifle-Bullets That Have Made the Long-Range Target Match a Contest of Endurance

By Captain Edward C. Crossman
Recorder Army Ammunition Testing Boards, 1919, 1920, 1921

A MARINE sergeant laid himself down on the turf at Camp Perry, Ohio, last September, with a queer modification of the service rifle and many boxes of ammunition. When he arose the ammunition was all gone—and so was the system of American long-range rifle-shooting targets.

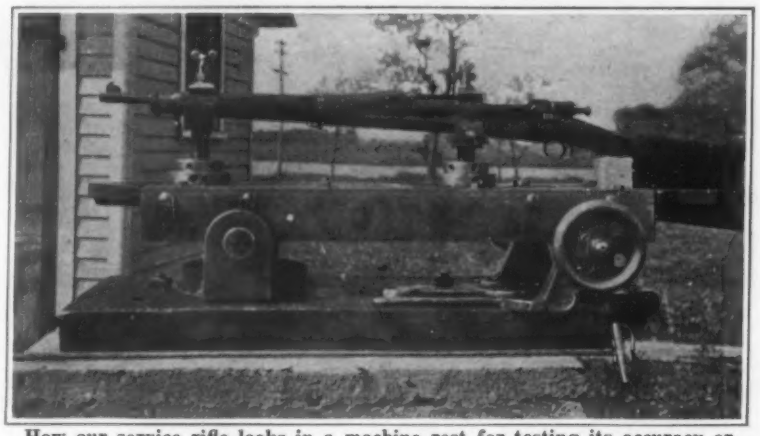
It was the last straw that broke the back of the long-suffering camel. Every long-range rifle-shooting record of this country or any other had been shot full of holes in the month before this score. From 800 to 1200 yards not only had the "possible" of 20 bullseyes in 20 shots been made in match after match, but prodigious additional strings of bullseyes had been run. But when the powers that be set up targets at 800 yards, with specially designed dim light-blue bullseyes just a yard in diameter, for the purpose of seeing what the telescope sight could do; and when a "Leatherneck" proceeded to swat this bullseye just 176 times in succession—then it seemed time either to change the targets or to put them back so far that the curve of the earth would interfere with seeing them.

Not only did this Marine sergeant run 176 consecutive bullseyes, but a shipmate ran out 131, a doughboy scored 116 and another Marine ran 98. A run of 63 bullseyes was good only for tenth place on the list! And this was at a distance of 80 yards less than half a mile, and at a bullseye just a yard in diameter. Other items that put the preliminary kink in the camel's back consisted of such performances as 900 yards, 80 consecutive bullseyes; 1000 yards, 77; 1100 yards, 66; 1200 yards, 41; and, at 600 yards, on the smaller 20-inch bullseye, 101 consecutive bullseyes.

The chaps who designed the ancient and honorable American long-range target with its 3-foot bullseyes, its 6-foot overall height and 12-foot length had no such idea in mind. In rifle shooting the target is supposed to offer sufficient difficulty so that a good shot may average around 90 per cent of the "possible" score, and the expert 95 to 98, with an occasional "possible" where he puts all his 10 or 15 or 20 shots into the black bullseye. When "possibles" became too frequent the range was lengthened or the easy stage eliminated. Our military rifles and ammunition became so accurate some years ago that the 800-yard range was eliminated from many matches; but this was merely because too many riflemen made "possibles," not because anybody even dreamed of a man's running 176 bullseyes.

The difference between ordinary good shooting and this sort of thing does not lie in the marksman. It lies in the rifle and in the bullet. The accuracy of the rifles used by the American long-range riflemen of the black-powder days of the eighties did not suffer by comparison with the high-velocity, small-bore military rifles that displaced these old "coal burners." In fact the coming of our Army Krag-Jorgenson and the inexperience of our armories in making both the rifle and the ammunition for it set back American match rifle-shooting many years. When it came to accuracy, the new rifle was not in the same class with the old .45-70 service Springfield which it displaced; and it did not have a look-in with the fine Sharps and other special match rifles with their ponderous bullets which they tossed into the far-off target over a path as curved as a rainbow. Its bullets were under-size, ill-formed, uneven in base, and uneven in weight. The powder charges were just as uneven.

As usual, it was the civilian riflemen, inspired by the progress made abroad, that forced a change; and our private ammunition factories showed the Government the way to make ammunition that would shoot, an oft-repeated performance ever since. The reason is that the private or commercial companies have to meet competition, while the Government arsenals didn't—until a cruel provision compelled them to get out in the open in straight competitive ammunition tests and make good or be shown up.



How our service rifle looks in a machine rest for testing its accuracy or that of its ammunition

About 1908 Congress passed a law providing that the Government purchase a million or more service cartridges each year from each of the private loading companies to encourage them to keep up the machinery for making Government cartridges, and to keep familiar with the process. Congress also provided that from each of these million-round lots there should be taken at random enough ammunition to determine the relative accuracy of each, and that the lot showing the highest accuracy should be used in the annual National Rifle Matches. That move was the start of the development of American-made match rifle ammunition worthy of its ambitious name.

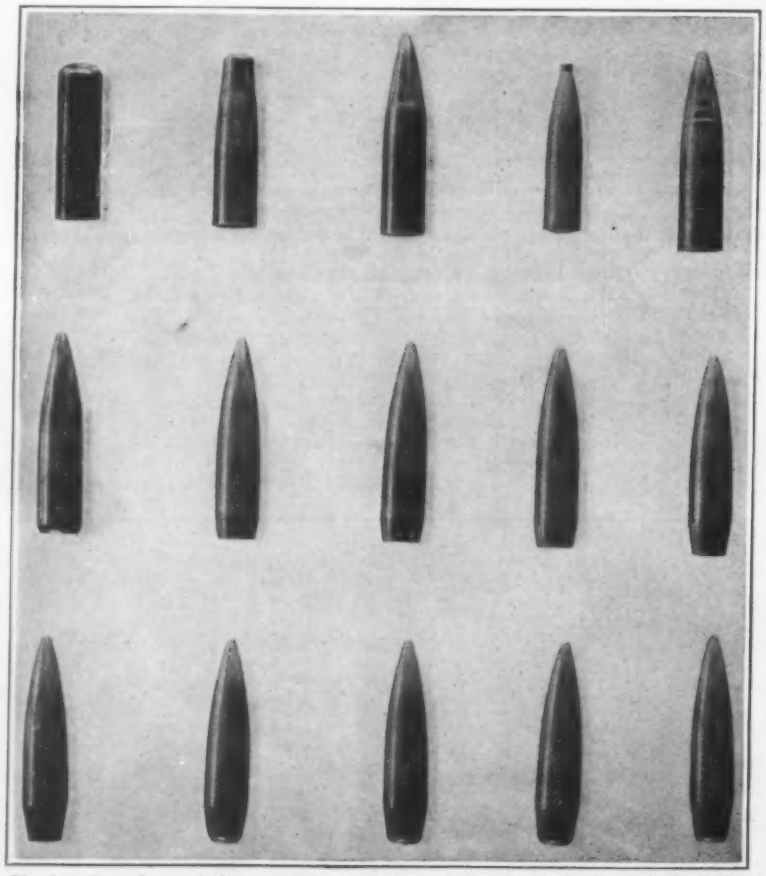
To win this machine-rest test with its attendant publicity and prestige among riflemen was an advertising feather in the cap of the winning company, and therefore the rivalry was keen. The Government's Frankford Arsenal was obliged to come out of its shell, take its feet off the desk, and enter the test with the commercial concerns. And while in the eight or nine open machine-rest tests held since this date the Government has never won a test, the mere effort to compete brought a much needed change in the moss-backed arsenal methods; and the service ammunition turned out for troops was much better than it might have been, had the spur of the test not been applied.

The improvement has not been lost, even though the purchase of ammunition from commercial concerns was abandoned before the war by our misguided Congress, led by the customary demagogue who thunders against the profits made off the Government by private concerns. So 1913, the last year of the statutory ammunition tests, saw ammunition for the service rifle in quite a high state of development. Still, nothing was done in the National Matches of 1913 to compel a revision of our targets. For example, the Wimbledon Cup Match has been staged for more than 40 years, with an interim now and then. It calls for 20 shots at 1000 yards, any rifle, any position, and any sights. Not until 1920 did any competitor put all 20 shots into the bullseye. Year after year 99 ex 100 took the coveted Long-Range Championship, carried by the trophy.

The Olympic Games of 1920 saw a renewal of international rifle competition after the war. Preliminary to the dispatch of the rifle team, the Government held a test to determine what ammunition the team would take to Belgium with it. Entrants were the Government Frankford Arsenal and three commercial companies. One of the latter won, with the Government arsenal a close second, thanks to the work of Captain Wallace Clay, one of the few ordnance officers who understood accurate ammunition making. The team shot, therefore, this match cartridge, using a 180-grain bullet at about 2600 feet per second. As usual, the team annexed practically every match on the Olympic program.

The year 1921 saw another international rifle match arranged at Lyons, France. Although not at all within our bailiwick, we decided to enter a team, and again an ammunition test was held to select ammunition for this team, and for the Palma team in case that historic match could be revived. This test was held at Quantico, Va., on the Marine Corps range, and was entered by the Frankford Arsenal and four corporate manufacturers. All of the companies submitted at least two different types of ammunition, some of them four types; so in all the Ammunition Board found 16 types of ammunition from which it had to select the most accurate for our rifle team. Incidentally the prestige derived from winning this test results in the winning ammunition being purchased in large quantities by the riflemen at the great national matches, held by the Government each year, even though Government ammunition is furnished free to all competitors.

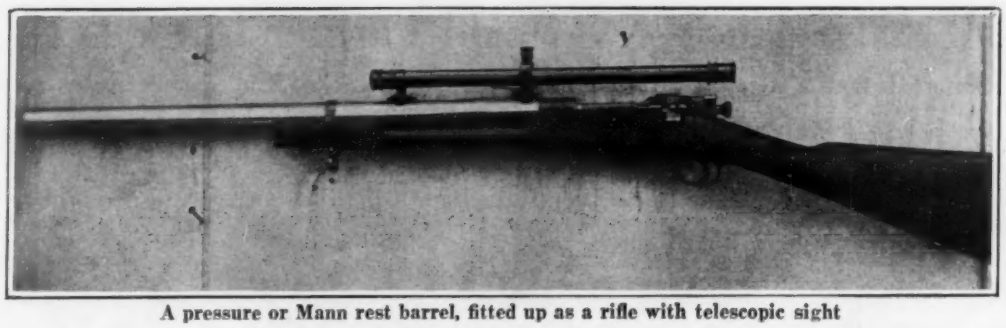
Once more, after a long and gruelling test in which 200 shots were fired through machine rest and Mann rest with each type of ammunition, the company winning in 1920 again won the 1921 test. Some interesting types of bullets were entered, the result of the keen interest of our factories in the test, the first opportunity they had found since the delirious days of 1914. The Frankford Arsenal's entry, for instance, carrying an electroplate of tin in



The first three shapes at the upper left are the empty bullet jacket; the fourth is the leaden core; the fifth, and the ten following views of the lower rows, are the assembled bullet with the core in the jacket

Successive stages in the manufacture of the boat-tail machine-gun bullet

order to overcome copper fouling in the bore, was largely successful in this aim, and developed in the bargain an accuracy most surprising for machine-loaded ammunition. More than two million rounds of this cartridge were loaded for the National Rifle Matches, and throughout the matches it displayed accuracy very close to that of the hand-loaded "match" ammunition which had won the machine-rest test and was taken to France by our rifle team. Indeed, the Government arsenal had no apologies to make for the ammunition it produced in 1919, 1920 and 1921, each year seeing an improvement on that of the year before, and that of 1921 outclassing the special match ammunition produced in years gone by with the slow process of hand-loading.



A pressure or Mann rest barrel, fitted up as a rifle with telescopic sight

The Mann type of rest for testing ammunition had shown such superior accuracy in the machine-rest tests at Quantico that the astute Marines, never overlooking a bet in the rifle-shooting game, took these heavy 1¼-inch barrels, knocked off the two concentric rings by which they rested in the "V" block of the rest and turned down the forward end of the barrels to lighten them a trifle. These barrels they fitted to specially made and more comfortable stocks than those of the service rifle, and then turned loose their best individual shots with this equipment in the matches at Wakefield, Sea Girt and Camp Perry.

The writer was the first to use one of these ponderous barrels in competition. It arrived at Camp Perry after the opening of the 1920 matches, and as no opportunity was afforded to sight it in, the writer put his telescopic sight on it, "bore-sighted" it on the target at 900 yards, and the next day took second place in the Adjutant General's Cup Match with possibles at 900 and 1000 yards and four bullseyes over. A few days later the heavy barrel took fourth place in the Wimbledon Cup Match with 99 ex 100, which up to that year had won or tied for the coveted trophy.

Evidently the Marines and others felt that if a "scrub" rifle, shot without practice, could come this close to the top there must be something in the overweight type of barrel, because the next year the range fairly blossomed with them. As a rule the barrels, unlike the ponderous affair the writer shot, were turned down, so that, while heavier than the service-rifle barrel, they were not so heavy as the full-size 1¼-inch pressure barrel, which brought the weight of the rifle up to 13 pounds and made it difficult to hold in a long string of shots.

Both Infantry and Marines fitted their "pot hunters" with these special guns, which were also sent to France in the hands of our rifle team. The team, incidentally, defeated the Swiss riflemen, the most formidable in Europe, at their own pet game of "free rifle," by using these heavy barrels and the wonderful ammunition furnished the team as a result of the ammunition test.

The chief advantage of the heavy barrel used by some of the record breakers in the astonishing runs of 1921 is that when used with telescopic sight, it heats so slowly that the change in the line of the bore with relation to the line of the telescope, if any occurs, is very gradual, and the rifleman noting the constant tendency of his shots to go higher and higher in the bullseye, or lower, depending on the barrel, corrects by means of his sight adjustment and keeps his group well centered. The ordinary-weight service-rifle barrel, heating up, is likely to alter its straight bore-line, and the telescope, mounted well to the rear, does not check up this slowly altering direction of muzzle. The heavy barrel, likewise, having little vibration or whip, gives the bullet greater steadiness of delivery as it leaves the muzzle.

The record-breaking scores made in 1921, however, were not due to the heavy barrels, although these aided in some of the long runs. In matches in which only the service rifle was permitted the records continued to go overboard and the targets to be shot into a condition of "innocuous desuetude." The true answer lies in the ammunition; and its preparation is an interesting study in uniformity. While the processes vary with the different plants, they use some or all of these precautions to ensure absolute uniformity from shot to shot.

The crux of the situation is the bullet. To make it for a match cartridge, the dies are usually new ones and are calipered and gaged to be sure they are absolutely correct.

Behold, then, the disc of cupro-nickel or copper, as the case may be, (not far from the size of a 5-cent piece,) started through a series of drawn presses—merely heavy dies with pouches fitting them, which gradually alter the disc until it emerges in the form of a modern sharp-point bullet, empty of core, and base open to the world, still lacking the fine forward lines of the finished bullet. It is then, with the lead core or slug, dropped into a die in a revolving steel plate, and a series of punches force the core into the jacket, forma the point, and turn over the base. The turning over, and forming a clean square base on the bullet to ensure even delivery from the muzzle of the rifle, is one of the secrets of making accurate ammunition.

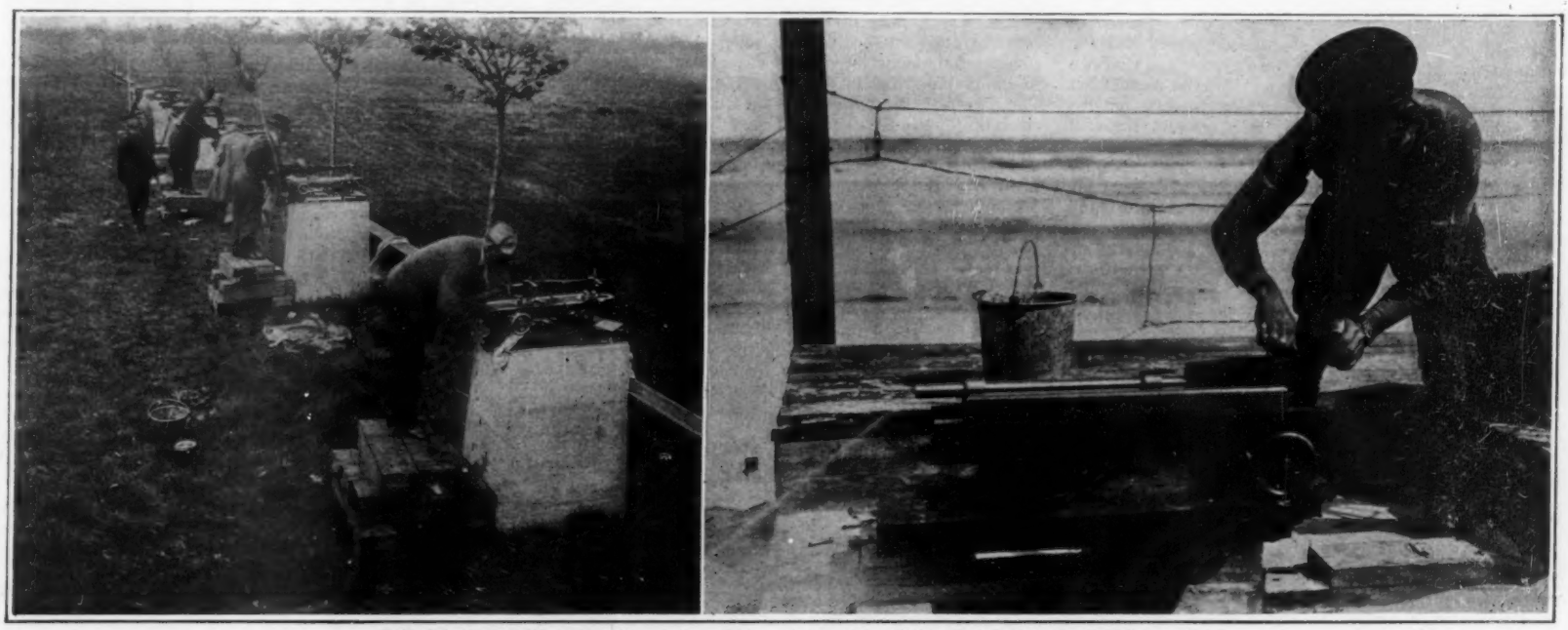
For match ammunition new dies are used to draw the cartridge cases, and every care is taken to keep the wall thickness uniform. Variation here means variation in powder room or "density of loading," in chamber pressure, in barrel vibration and in muzzle velocity, none of which is compatible with putting ten shots in about the same spot on the far-off paper.

Some factories go to the trouble of weighing the primer pellet to ensure the same strength of ignition flame. All of them hand-weigh their powder charges, using fine balance scales and adding kernel by kernel until the charges are uniform to 1/20 of a grain.

The bullet gets more inspection than a prize Jersey at a county fair. It is first weighed, and it must correspond with the weight of its fellows within a grain or less. It is then calipered, with only a couple of ten-thousandths of an inch between it and the discard. It is finally "spun" for eccentricity, which is a standard test. In this stage of the inquisition the bullet is gripped by its parallel portion to the rear, in the jaws of a little "chuck," and is then spun on its long axis, with an indicator at its extreme point. If this point departs more than a few thousandths of an inch from absolute trueness, it is an object of suspicion. One factory went to the trouble of spinning its empty cases with an indicator at the neck, and then, when the bullet had been loaded into the case, and the cartridge finished, again spun the entire cartridge with the indicator at the point of the bullet. A bullet seated crookedly in the case would be forced a trifle off-center into the chamber and might therefore travel the bore length and emerge with an eccentric spin.

With all of this painstaking care, more suitable to the laboratory than a factory, machine-loaded ammunition in which human hands play a very small part has been brought up to a stage that is most flattering to the chaps who have worked out the processes, in that the ammunition is nearly as accurate as the hand-prepared brand. The part human skill plays in machine-loading ammunition lies in the careful making of the dies and measures, in the careful setting up of the machines, and in the careful inspection of the components of the cartridge.

It is very doubtful if the finest ammunition plants in Europe could produce by any process whatever, ammunition as good as the two million cartridges made by the Government Frankford Arsenal for the matches of 1921, by machinery. Certain it is that no British cartridge ever ran 71 consecutive bullseyes at 1,000 yards—and the British factories are about the only factories of Europe that an American rifleman would take seriously. And that is why, if rifle matches are not to degenerate into endurance contests with scores resembling those rolled up by the modern school of billiard players, something has to be done about the targets.



Left: **A battery of rifles in machine rests ready to go into action.** *Right:* **A study in firing the Mann rest**

Target practice as it is conducted under precision methods

Science—A World Partnership

Some Remarks Upon the International Character of Successful Research

By Dr. W. R. Whitney

Director, Research Laboratory, General Electric Co.

LONG before so-called industrial research laboratories were established in any country, there existed a very thorough international cooperation in scientific research. The paths of scientific discovery were intentionally so blazed by the pioneers that others could follow. A wish to conceal natural laws has seldom developed among natural scientists. It would be difficult to find any considerable group of new phenomena which were purposely long concealed. It has always been bad form to bury a living truth. In the world as we fortunately find it, most of those who study fundamental phenomena take great pains quickly to add their contributions to the immense mass of carefully tested physical truth which constitutes the greatest inheritance of our civilization. This act is founded on such simple traits in human character that general scientific cooperation will be as enduring as international peace will ever become. In this article Dr. Whitney points out the extent to which the world's great scientific advances have been made as the result of contributions from several different countries—from all the world, in fact; and he points out the significance of this fact, as he sees it.—THE EDITOR.

LONG before the introduction of printing, it was customary—and more necessary than now—for students to apprentice themselves to the masters, in foreign countries, that they might learn the new principles which these men had learned by experiment.

The recent excavations of the tombs of Egypt reveal that nearly 5,000 years ago it was customary to show by drawings and even by models just how far the science and arts of the period were developed. From these excavations we now know, even to the physical dimensions of all the apparatus, how they made bread and beer, forty centuries ago.

Before we knew that there were any differences between gases, and when air as a thing was just beginning to be discovered, a whole world of scientific men cooperated on the gas laws, the base of so much of our power. Torricelli in Italy, showed that the air pressed up the mercury column of his vacuum tube. Guericke, in Germany, soon published his discovery of a vacuum pump. Boyle in England published his work on "The Spring of the Air." About this time Stahl in Germany, Cavendish and Black in England, and Lavois in France, described their experiments on gases, and Scheele in Sweden printed his book "On Air and Fire." All these and many others fixed forever the custom of international cooperation in scientific research.

Therefore, whether we look at the endless line of researches which are being published in all corners of the globe as the outcome of would-be beneficence or of self-seeking, the process and the product are continuous and fixed as to method. There is little danger that any country will ever advance through systematic concealment of new discoveries. There is every assurance that those conditions which have hitherto insured the advancement of learning and the pursuit of happiness are perpetual.

To those who, before the war, attended the international scientific congresses, such as those of Applied Chemistry, there had come the feeling that if freedom from wars could ever be brought about, it would come through the applications of science. The world had been unified as to aim in acquiring physical truth and all countries were contributing what they could. The foundation stones of this structure are still untouched, so that hope is still justified, and as the magnitude and the quality of the stones transcend the temporary and wooden structures which are sometimes erected upon them, we may depend on the long tested habit of broadcasting new light.

If we examine the lines of electrical work now being developed, or the engineering problems which call for the activities of a research laboratory, we see that we owe to men in diverse countries most of the foundation on which we work. This debt, which is very general and widespread, must some day be a ground for still closer contacts. These will be greatly facilitated by the modern accomplishments in rapid intercommunication and by industrial expansion. As we look back over the work of our own laboratory, we can find many cases where our undertakings depended on the earlier studies of scientists in many countries.

Thus the published work of a few widely scattered pioneers had established many facts about the metal tungsten. Dr. Coolidge, starting from these facts, by prolonged and extensive research, developed the complete metallurgy of tungsten, and showed how to work it into wires, rods, plates, sheets, and other desired forms. His work not only resulted in giving to industry the drawn-filament tungsten lamp, but it also added to the world's stock of available metals a new one of the greatest utility, particularly in vacuum tubes of many kinds, and of value both to industry and to science.

There is a strange and interesting thing about the utilization of new knowledge which warrants the general instinct for publication. This is the fact that new knowledge (differing from the material things of which it treats) is not consumed by the using, but rapidly increases thereby. To use a new fact in connection with an experiment is always to add to the stock.

What we learned about tungsten as wire we applied in the metallurgy of molybdenum and thus disclosed not only the similarities, but the differences between these metals. One such difference became an apparent necessity to the Coolidge X-ray tube. The tungsten target is supported on a rod of molybdenum. All other metals tried for this use failed because of either low melting-point or high brittleness.

The properties of tungsten having become known through the work on lamp filaments, and the Coolidge process for obtaining the ductile metal having been devised, it was soon evident that here was a substitute for the rare platinum of electrical contacts and of the common X-ray tubes of the day. When, later, the researches on X-rays were continued, Dr. Coolidge developed a new X-ray tube which made use of the following combination of several modern contributions from our own laboratory. The metal itself was found to be one of very few elements which could be used as target in an X-ray tube. A new principle, involving the pure electronic emission from a tungsten cathode of controlled temperature, was applied and a new degree of vacuum was utilized which, up to that time, had not been used.

This whole X-ray development fitted into the picture with that group of French contributions to science which centers about radioactivity and short ether waves. We cannot here go into the great effect that this has had upon fundamental ideas of chemistry, but it is fair to point out how closely interrelated and important are all such separate scientific discoveries. The radium and other decaying elements are emitting energy of the shortest known wave length, and so have to be included in a review of the radiant spectrum. Thus we find Becquerel and the Curies, of France, cooperating with Crookes, Ramsay, and others of England. Soon there was hardly a physical laboratory in any country which was not contributing to this subject, until, for the humane purposes of healing, our own western miners were included in this complex system and were mining the major portion of the tungsten for X-ray tubes and most of the world's radium in the one state of Colorado.

At the other end of the radiant spectrum, among the long waves, there has been equal activity, and there, too, the contributions have come from various countries. The research has been international. As the individual ant in an ant-hill may have little conception of the bearing its own activity may have upon the life of the colony which depends upon it, so a man like Maxwell in England, led by what was probably just a dominant theoretical interest in physical mathematics, published his work and laid a corner stone on which Hertz, in Germany, could base his remarkable researches on electric waves. These made it possible in turn for Marconi, in Italy, to make wireless a useful thing.

While these names come first when we think of long ether waves, there were here (just as with the short waves) a host of investigators in many countries, who published their researches. While we cannot follow all the threads of such an intricate structure, we may well point out one group of researches which is still under way in our laboratory and the origin of which can be traced back to individuals in widely separated parts of the world. They described their experiments for the advance of the science and the information of other students. Thus the genesis of glass tubes used for wireless receiving, for amplifying, and for high-frequency wave generation, can be traced back to such observations as the Edison effect, first observed in incandescent carbon lamps. Fleming, of England, published an extensive scientific study of this phenomenon, and Elster and Geitel, in Germany, added greatly to our experimental knowledge of the electrical phenomena of highly heated surfaces.

The attempt on the part of Richardson to derive mathematical laws of electronic emission from hot bodies, led to a collection of the research work of a score or more of investigators, and these contributions came from every part of the scientific world. The whole international literature in the field of physics has now been filled with it.

There still remained many apparent inconsistencies in experimental results and many contradictory conclusions drawn from them. Dr. Irving Langmuir devoted himself to a study of the subject and was able to clear up the inconsistencies and contradictions, to publish a complete analysis of the phenomena and their underlying laws, and to point the way to their utilization in vacuum tubes of high power and of various kinds. The pliotron, which has made long distance radio telephony practicable, was among these. The researches which led to the Coolidge X-ray tube were made possible in part by Langmuir's fundamental studies on emission.

In the course of these studies, there were developed means for producing and for measuring higher degrees of vacuum than had been used before. The new tools for scientific use thus produced Langmuir himself utilized in the study of chemical reactions at low pressures, and thereby made important contributions to chemical theory which have been widely published.

These few examples serve to show that the scientific investigations in different lands contribute to the knowledge of all and lead to the technical activities of those who wish to advance in any country. It is apparent that the world is becoming much more closely united by its long established cooperation in scientific research. It seems probable that all the modern discoveries which have led (almost within the lives of the present generation) to intimate relationships in science and industry, to the continuing obliteration of man-separating space and time, will play their part in the desired preservation of peace.

Ore Deposits Revealed by Plants

IT has been known for a long time that certain plants indicate the presence of deposits of minerals under ground. In the Proceedings of the Australian Mining Institute, E. Lidgely has summarized several remarkable examples where beds of ore were revealed by plants growing on the surface above. The Amorpha canescens shrub indicates the presence of galena, the lead sulfide ore, in Michigan and Wisconsin, while in Missouri a plant belonging to the poison sumach family serves the same purpose, as a lead ore indicator. Beech trees often indicate that limestone beds are to be found in the neighborhood. In Spain a sort of bindweed, known as Convolvulus althaeoides, is deemed of high value in betraying the presence of underlying deposits of phosphate ore. The plant Erigonum ovalifolium discloses the existence of silver ores in Montana. The calamine violet, which grows in Upper Silesia, Westphalia and Belgium, is a sign of the existence of calamine, the zinc ore, in the neighborhood. Near the city of Siegen in Westphalia the presence of iron ore deposits over a considerable acreage is indicated by the fact that the surface of the earth is covered with birch trees, while the ground surrounding this section on all sides bears only oak trees and beech trees.

The Eight-Wheel Bus

By C. W. Geiger

SAN FRANCISCO pedestrians are dodging a new eight-wheel bus which is a radical departure in design and construction from those previously in use. The bus carries 20 passengers, there being five cross seats, with doors for each seat, and two doors for the driver's seat. There is a special compartment in the rear for baggage, which is really a part of the body. Under the baggage compartment is a special compartment which carries two spare tires, inflated on their rims.

The eight-wheel construction of this bus gives much greater flexibility and smoothness, with less wear and tear on tires and pavements

The bus has not skidded since being placed in operation (a very desirable feature in bus construction) although the driver deliberately made an attempt while traveling on wet pavement at 25 miles an hour by throwing the clutch out and jamming on all brakes. When traveling around a curve at 48 miles an hour the swaying of the body was imperceptible, this being due to the special features embodied in the chassis and special spring suspension.

The center of gravity of the bus and load is very low, due to the small wheels used, 32x4½ tires being used. Only 70 pounds of air is maintained in the tires, as against 120 pounds, which is used in four-wheel buses. It is thought that there will probably not be half as great strain on the pavement as comes from the four-wheel bus, due to the eight bearing points and the 50 pounds less air pressure in the tires. By virtue of the spring suspension and by having eight points striking, passengers only feel a flutter when the bus passes over a series of railroad tracks. There is less fatigue in riding in this bus than in the best makes of passenger cars, a feature that is sure to make the eight-wheel bus popular with the traveling public.

A special engine has been designed for this bus. The cylinders are 4¼x5½. The car has been driven over 2400 miles, and has been given most severe tests, and in every case has far exceeded the expectations of the designer. It was recently driven to Los Angeles from San Francisco in 15 hours, despite the fact that there were two bad detours. The car made 10 miles per gallon of gasoline.

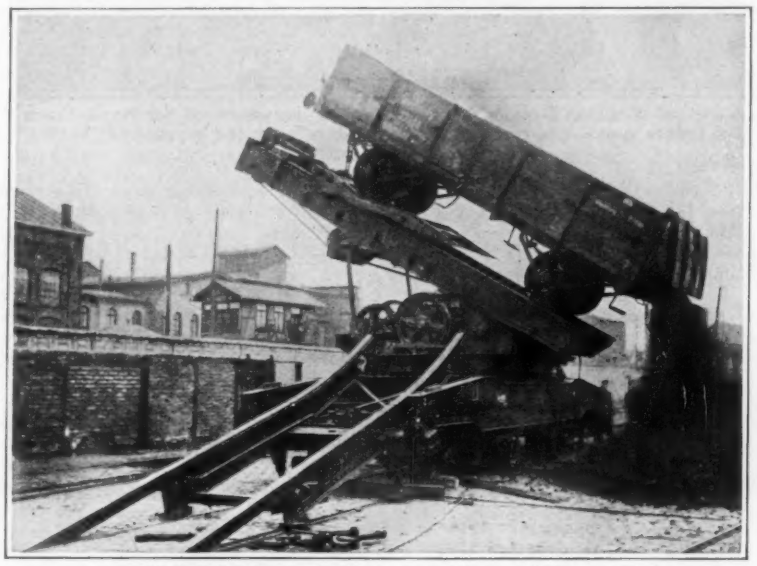
The bus steers on all four front wheels and drives and brakes on all four rear wheels. The construction is such that any one of the four front or four rear wheels may be on an eight-inch curb and still carry the same load as the other three wheels which are on the level, without any undue strain upon the frame.

Coal Production in Ecuador

THE American Consul General at Guayaquil reports that lignite is found in many parts of Ecuador, particularly in the Provinces of Pichincha, Azuay and Loja. This lignite is used to some extent locally, although not of a superior quality. It is claimed that in the Province of Chimborazo, near the village of Penicuche, there are three veins of coal; the upper, about 60 centimeters of inferior quality; a second, 30 to 50 centimeters, which is a better grade; and a third, which is almost one meter in thickness. All of these veins belong to the class of anthracite coals. No scientific tests have been made as to their value as a combustible. Two mines are in operation in the Province of Canar, one at the town of Deleg and the other near Biblian. The veins of these mines are of considerable thickness and the product is used locally in lime-kilns. Some years ago an American company was organized to develop this industry, but owing to lack of transportation facilities the project was abandoned. A test of this material made by the Guayaquil & Quito Railway Co. was not satisfactory, but it is believed that it possesses sufficient fuel value for many ordinary industrial uses.

Unloading with the "Tilting Truck"

CAR-LOAD dumping is by no means a new story; but as practiced in this country it usually involves the action of something in the way of a crane. The loaded car is picked up bodily, swung through space, perhaps merely tilted or perhaps actually gripped and turned cleanly upside down. We illustrate a German invention for dumping car-load lots with somewhat less speed and very much less expense than is required for the construction and operation of these enormous cranes. It has been in use for a considerable period, and has given every satisfaction.



An artificial hillside to facilitate unloading of bulk materials

The device in question is known as the "tilting truck." Operation commences with the truck at right angles to the position in which our photograph shows it—parallel with the up-standing track section and, in fact, forming a continuation of this. The extreme outer longitudinal faces of the truck on either side are of rail section to give effect to this continuity. The loaded car is pushed up the incline and on to the tilting truck—or hauled up by means of a cable, as convenience dictates. Once in position, it is firmly locked in place and the tilting truck unlocked so that it may be swung about through an angle of 90 degrees into the position shown in our photograph. The end-board of the loaded car is then dropped, or if it be of the hopper type its hopper at the lower end is opened, and dumping is immediately taken over by that well-known worker, gravitational force. Once successfully dumped, the track on which the now empty car stands is swung back into line with the rails, and the car rolls off to make room for another.

The "tilting truck" is misnamed, if this term conveys the impression that it tilts and rights itself periodically during operation. It might better be called, in English, the "tilted truck"; for it ordinarily maintains a constant angle with the horizontal throughout. At the same time, its pitch can be varied to accommodate itself to the "angle of repose" of the material being dumped; and it is possible that this angle might be so great as to make it more economical to tilt it after the car has been mounted than to run the car up such a steep incline.

A Notable Pontoon Bridge

By James Hendrickson

AN extremely interesting structure is the pontoon bridge located at Dardanelle, Ark., spanning the turbulent Arkansas River, joining Pope and Yell Counties. The bridge is 2065 feet long from bank to bank, but the run-ways at each end will bring the distance from end to end to nearly 800 yards. Work of constructing the bridge was started in 1890 and completed about a year later at a cost of $25,000. Since that time it has been swept away, sunk by heavy snows and torn to pieces by storms on several occasions, but has never been out of use for long at a time.

There are 72 pontoon boats in the bridge, spaced 24 feet from center to center. They are anchored in line, the bridge being held against the current with wire cables attached to towers filled with rock. Three of these towers placed at regular intervals in the stream are now in use.

The dimensions of each pontoon boat are: depth, 36 inches; width, 12 feet; length, 28 feet. The boats are coupled in sections, six boats to a section. There are nine sections and all may be easily moved to the edge of the river when a storm is seen approaching, or repair work is needed quickly. A steamboat is maintained by the company owning the bridge to remove the draw section and permit other boats to pass, or to tow the bridge to the bank when driftwood is heavy or the river high. The steamboat is used as a ferry when the bridge is not in use.

A sectional, demountable pontoon bridge four-tenths of a mile long in Arkansas

The first bridge constructed at Dardanelle had framework of heavy oak piling driven into the sand of the river bed some 800 feet out from the north shore. The main channel was spanned by pontoons upon which the frame of the roadway rested, constructed of pine.

The draws of the present bridge are under the direction of the War Department and have been changed at rather frequent intervals as the channel changes. Fares are regulated by legislative enactment and are not excessive. The bridge was authorized by the War Department and is still under its direction, as far as the river spans and the obstructing of navigation goes.

After Ashokan—What?

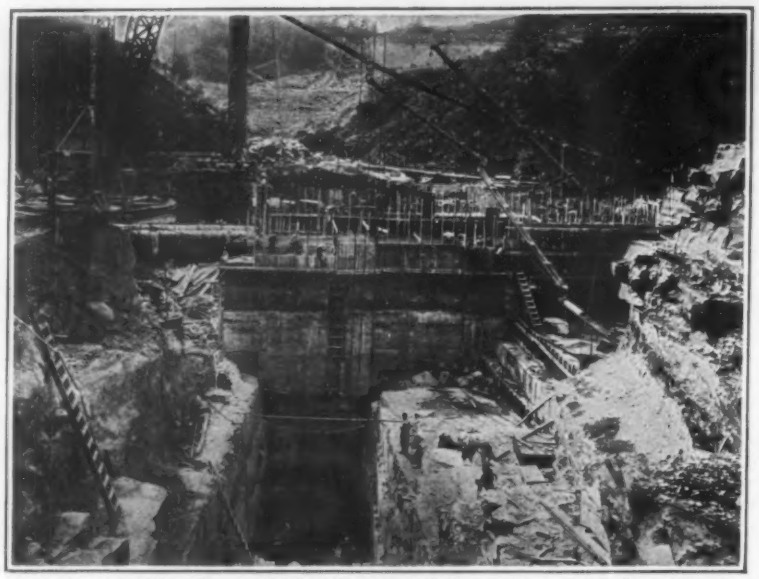
Doubling the World's Biggest Water-Supply System to Take Care of the Future

By S. G. Roberts

WORK on the Schoharie development of the Catskill water supply system of the City of Greater New York is going forward at a gratifying rate, and much has been done upon this momentous project since it was last dealt with in the pages of this journal.

We are told that the undertaking is comparable with the Esopus development, which boasts the Ashokan Reservoir, inasmuch as each of these projects will ultimately be relied upon to yield a daily volume of 300,000,000 gallons so as to take advantage of the total carrying capacity of the main aqueduct. But this statement quite fails to stress those engineering features of the Schoharie division which give it a claim to distinction.

Broadly speaking, work in connection with the Schoharie divides itself into two departments: one having to do with the Gilboa Dam, by which the natural flow of Schoharie Creek is reversed, and the other relating to an exceptionally long tunnel through which the waters impounded by the dam will be led right under a mountain range and emptied into Esopus Creek—the latter being tributary to the Ashokan Reservoir. The site of Gilboa Dam is 156 miles away from the Silver Lake Reservoir on Staten Island, which constitutes the southernmost terminal of the Catskill water supply system. This fact is suggestive of how far afield the Metropolis has gone to obtain a plenty of pure water for its continually growing populace of millions of residents and for the daily demands of many hundreds of thousands of transients.



A section of Gilboa Dam, which will impound the waters of Schoharie Creek. The trench running at right angles to the dam is for the purpose of "keying" the big barrier to the rock

Schoharie Creek is fed by lesser streams having their sources at elevations of nearly 2000 feet; and the watershed covers an area of 314 square miles. The character of this watershed is mountainous and steep and is formed of shale and sandstone, with a covering of dense forest growth. The streams are subject to freshets in the springtime, and, because of the nature of the terrain, the flow into these waterways is especially large in proportion to the rainfall. That is to say, 69 per cent of the precipitation seeks an outlet by way of Schoharie Creek. Owing to these conditions, the Schoharie is what is termed a "flashy stream," and its control has, therefore, called for exhaustive study on the part of the engineers.

The Schoharie Reservoir is to be 5.8 miles long, 0.7 miles in maximum width, and will have a maximum depth of something over 150 feet—the average depth being 57 feet. Its shoreline will trace a distance of 16.5 miles, and the area of its water surface will be 1145 acres. The acquisition of the reservoir property has required the construction of 12.4 miles of highways to replace 13.6 miles of abandoned roads, and two steel bridges have been built in connection with the new thoroughfare system. The City of New York has acquired a marginal strip around the shoreline of the reservoir to insure the sanitary protection of the water.

Notwithstanding the extensive region drained and the precipitous slope of the land, the Schoharie Reservoir will have a service capacity of but 20,000,000,000 gallons—less than one-sixth that of the Ashokan Reservoir into which pours the runoff of a territory embracing only 257 square miles. This means that after the artificial lake has been filled the excess will be carried off over the crest of the Gilboa Dam and led thence to the intake of the Shandaken Tunnel. During freshet periods there will pass daily over the top of the dam quite 600,000,000 gallons of water—the maximum capacity of the tunnel—and this water will have a drop of 150 feet before reaching the creek and speeding on to the tunnel's mouth.

To break the momentum of this descending flood and to rob it of its power to do damage, the overfall portion of the masonry section of the dam, *i. e.*, the down-stream face, will be made up of a succession of great steps ranging from 7 to 20 feet in tread and rise. The dimensions of these steps have been tentatively agreed upon rather recently after a protracted series of model trials upon a scale somewhat larger than was the case when the first experiments were conducted about two years ago. In addition to the stepped spillway there will be a kindred terraced spillway channel set at right angles to it, and this channel will reach across 90 per cent of the down-stream face of the dam. This arrangement will bring the falling waters together from two opposing directions, will tend to diminish their inertia and send them with slackened speed thence to the aqueduct beneath the Shandaken mountains.

For the sake of those unfamiliar with the project, let it be said that the Gilboa Dam will consist of two main parts: an overfall masonry section about 1300 feet in length and an earth section, 700 feet long, strengthened by a core-wall. The masonry portion of the structure will have a height of 180 feet and will be 17 feet through at the top and 150 feet at the bottom. Work on the dam is well underway, and the masonry is being reared in units 75 feet in length between contraction joints. These joints will extend completely through the dam from front to rear and from foundation to crest. A copper strip one-sixteenth inch thick by seven inches wide will span each contraction joint and act as a stop-water. The dam is now 17 per cent finished; and this phase of the Schoharie development will ultimately involve an outlay of nearly $7,000,000. The contractor has had a troublesome task in building cofferdams and in installing pipes for controlling and diverting, for the time being, the regular course of the creek so that the bed of the stream could be bared and the underlying rock excavated for the cut-off. This deep trench is channeled and blasted out of the ledge; and when filled with masonry it keys the dam to the primordial rock.

The 700-foot earth section on the west bank of the Schoharie is necessitated by reason of the pre-glacial gorge which, at that point, lies under the mountainside. This great embankment will rise to a height of more than 100 feet, will be 32 feet wide across the top and will be substantially 445 feet thick at the base. It is worth while recalling that this region was successively subjected to glacial movements at different periods; and the manner in which the rock is folded repeatedly upon itself bears mute witness to the far-off ages when mountains of ice ground their way along the valleys of the Catskills. While quarrying operations were in hand a short distance below the dam site there was uncovered a number of remarkably preserved fossil tree stumps. We are told that these fossils are of the very oldest flora which has ever been discovered; and it is estimated that those trees flourished something like 300,000,000 years ago!

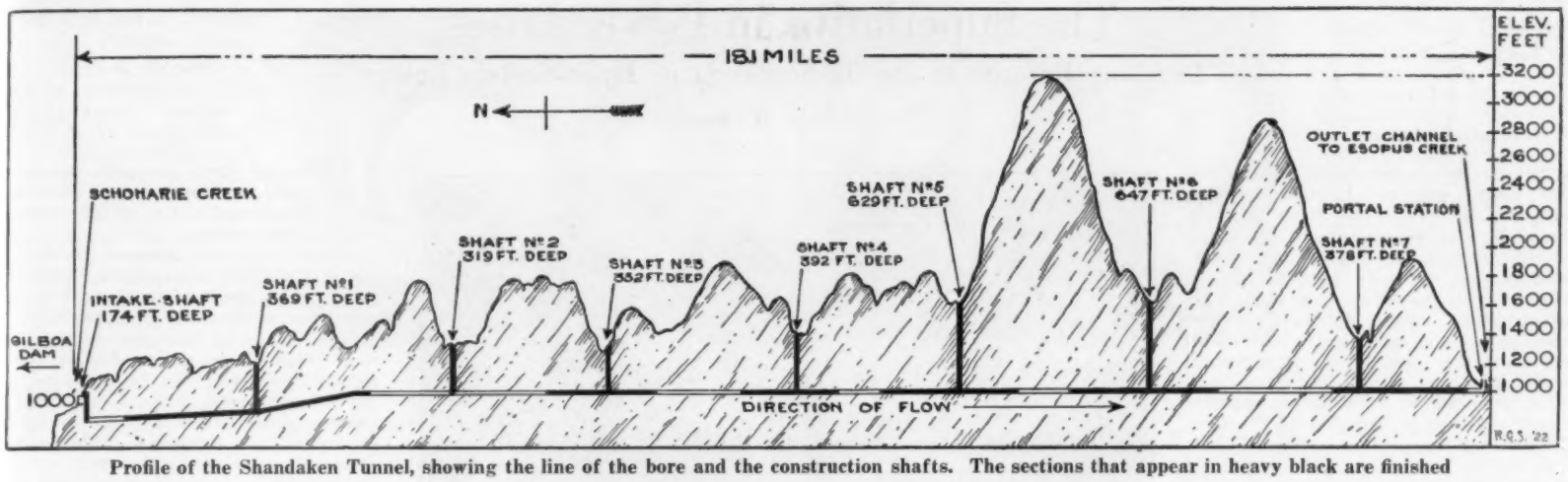
From now on, the rearing of the Gilboa Dam will merely repeat in practice what was done in erecting those two other masses of cyclopean masonry—the dams for the Ashokan and the Kensico reservoirs.

Fossilized tree-trunks found in the quarry from which stone for the Gilboa Dam was cut

Undoubtedly the most interesting department of the Schoharie development is that having to do with the Shandaken Tunnel, which is now 53 per cent completed. This tunnel, from end to end, follows a line 18.1 miles in length and is 1577 feet longer than that artery of the Catskill aqueduct which pierces Manhattan Island from end to end—heretofore the longest tunnel in the world. The famous Simplon Tunnel, which passes through the Alps, is but 12½ miles between portals.

The Shandaken Tunnel is horseshoe-shaped in cross section, and its inside dimensions, after being lined with concrete, are 11 feet 6 inches in height by 10 feet 3 inches in width. For most of its course it is being driven on a uniform slope of 4.4 feet to the mile. However, for a distance of 3½ miles southward from the intake shaft, the tunnel mounts a sufficient gradient to make that stretch a pressure aqueduct and cause it to be filled with water. Except when the Schoharie is at the flood, the tunnel generally will be only partly filled, and the water will descend by gravity to the southern portal, where, it will be discharged into Esopus Creek.

As indicated by an accompanying diagram, the initial steps in driving the Shandaken Tunnel consisted of sinking seven shafts intermediate between the tunnel intake and its outlet. The aggregate depth of these several shafts is a matter of 3260 linear feet; and the deepest single shaft had to reach from the valley's surface through 647 feet of rock down to the designed line of the tunnel. The minimum



Profile of the Shandaken Tunnel, showing the line of the bore and the construction shafts. The sections that appear in heavy black are finished

interval between shafts is 1.3 miles and the maximum stretch is 2.7 miles. All of these shafts are circular in section and lined from top to bottom with concrete. This was necessary to reinforce the exposed rock and to arrest its tendency to spawl when exposed to the air and subjected to the readjusting stresses set up by the internal pressures of the penetrated rock-mass. All but one of these shafts have actually been used in advancing the tunnel headings. Operations have not been carried on from shaft No. 2 owing to the comparative isolation of its position, but the contractors have neutralized this by their increased activity at the other points of attack.

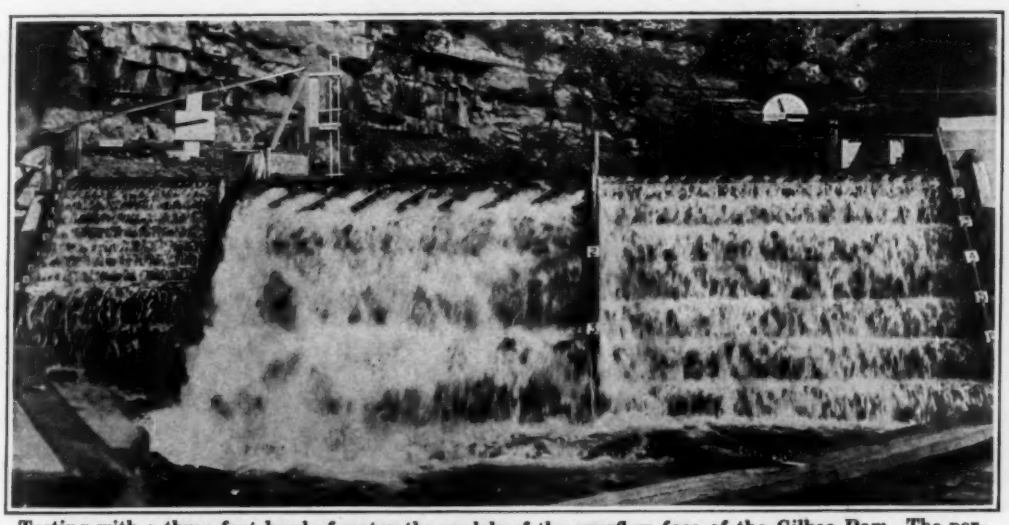
While the rock through which the shafts were sunk was generally sound enough to require no support prior to lining, still the ledge was found to be noticeably inferior in quality at shafts Nos. 2, 3 and 7. The excavations were made through red or gray sandstone and lesser areas of green and red shale. The shale encountered in some sections of the tunnel has given the engineers a good deal of trouble because of its tendency to "slab off." This action is due to the drying out of the rock water in a short while, which brings about the disintegration of the shale and turns it into a clay-like substance.

At the earlier stages of the work, slabbing was checked by recourse to permanent timbering—an expensive and tedious procedure. In search for a more economical remedy, and one that could be applied rapidly, the builders experimented with fine concrete which they applied to the rock surface by an atomizing machine functioning upon the basic principles of the cement gun. The upper half of the tunnel between certain sections was treated with three coats of this fluid concrete, composed of one bag of cement, three bags of sand, and five gallons of water per mix. Each coat, according to the local needs, ranged in thickness from half an inch to one inch. The portions of the tunnel so dealt with have stood for months without other protection and have shown no signs of weathering or cracking. This is a temporary measure inasmuch as the tunnel will ultimately be lined throughout with a veneer of concrete several inches thick.

In the prosecution of their task, the contractors have made liberal use of compressed air to drill the necessary blast holes at the headings; and by mounting their air tools on supporting vertical columns they have found it practicable to employ five drills at one time in drilling the holes throughout an entire section. When the holes are charged and the dynamite is set off, the resulting "muck" or shattered rock is handled by electrically operated shoveling machines, which pick up the spoil and pass the stuff rearward where it is automatically loaded into metal cars which are drawn away by small electric tractors. So well was the work proceeding during the latter part of 1921 that in the course of one month, at the 12 headings, an advance of 5593 feet was made; and the maximum weekly rate of excavating at the 12 headings reached 1362 feet. The best performance at a single heading during a week pushed the tunnel section forward 150 feet. These records are fine ones, and reflect the enterprise of the personnel and the skill with which the up-to-date facilities at their disposal are being utilized. The estimated cost of the Shandaken Tunnel is put at $12,138,738.

It is difficult to give an appreciative grasp of the magnitude of the Schoharie development in its entirety, but the following figures, furnished by the Board of Water Supply, may be of some help in this respect: The construction of the dam includes about 396,000 cubic yards of earth excavation, 92,500 cubic yards of rock excavation, 617,000 cubic yards of refilling and embanking, 436,000 cubic yards of masonry, and the use of 480,000 barrels of Portland cement; and the building of the tunnel will involve about 600,000 cubic yards of rock excavation, 100,000 cubic yards of earth excavation, 200,000 cubic yards of concrete masonry, and the employment of 445,000 barrels of Portland cement.

The primary energy is electricity, and, to furnish current for the tunnel work, a high-tension transmission line was built from Saw Kill, near Kingston, where connection is made with the wires of a public service distributing system. This line is 48 miles long, and was later extended six miles to supply current for the activities at Gilboa Dam. The undertaking is being carried along so rapidly now that there is every reason to believe that the Schoharie section of the Catskill water supply will be available for service before the close of 1924.



Testing with a three-foot head of water the models of the overflow face of the Gilboa Dam. The performance of these models gives tentative data on that of the finished dam

Novel Uses for Ultra-Violet Light

IT is only within recent years that powerful sources of invisible ultra-violet light have been available, but they have already been put to many novel uses. Such sources include the quartz-tube mercury-vapor lamp (which, according to some authorities, yields as much as 30 per cent of its total radiation within the ultra-violet region) and arcs between tungsten electrodes, which are known to be particularly rich in the invisible ultra-violet rays. In either case the radiation is passed through a plate of special glass, practically opaque to visible light but highly transparent to the ultra-violet. Any lenses used must be of quartz, which is likewise pervious to light of short wave-length. By this means we can concentrate rays which are invisible, but chemically active.

One use to which such rays have been put is the testing of the permanence of colored fabrics. It is stated that dye manufacturers in the north of Germany used formerly to send their products to the sunny south, where they could be exposed to bright sunlight for many months, with a view to testing the degree of fading of the colors. Nowadays, however, such tests can be made, independent of climatic conditions, by exposing the dyed fabric to the light of the quartz mercury tube, and the process can be completed in a far shorter time than was formerly necessary. It is probable that ultra-violet rays have similar chemical effects on many materials. It has been conjectured that deterioration of brass parts is in some cases due to their action and they are also said to be of value in completing the tanning of leather and for various sterilization processes. All this gives us an entirely new theoretical basis for investigations of fading, and an improved practical technique.

Perhaps their most interesting applications, however, are those connected with the "fluorescence" excited to some degree in almost all materials by intense ultra-violet light. Many substances, when exposed to the rays in a dark room glow quite brightly, and the color and intensity of the glow furnish a new means of analysis. Certain lubricating oils, for instance, and fat and greasy substances, show a pronounced glow and can be distinguished one from another by this means. Paper may often fluoresce. During the war, as it is now known, attempts were made to convey messages by writing in materials which left no trace on paper inspected by visible light but revealed fluorescence under ultra-violet light.

At a recent meeting of the Illuminating Engineering Society in London the application of the rays to the testing of gems and precious stones was demonstrated. The expert can by this means distinguish a true gem from an imitation one. Artificial pearls are at once distinguished from genuine ones. Moreover—what is specially interesting—it is even possible to distinguish, quite easily, natural Oriental pearls from those of the Japanese cultured variety. The color of the fluorescence in the two cases is quite distinct. It is conjectured that this difference is due to the fact that the pearls develop in different depths of water, and also, possibly in water having different solid materials in solution or suspension.

Confirmation of the effect of the surroundings in which gems develop is to be found in the interesting fact that even stones of the same kind, diamonds, for example, do not fluoresce identically if they come from different regions. This property may prove useful in determining the difficult question that often arises, whether two or more stones have been made by cutting up a large gem into several smaller ones, or whether they are of quite distinct origin.

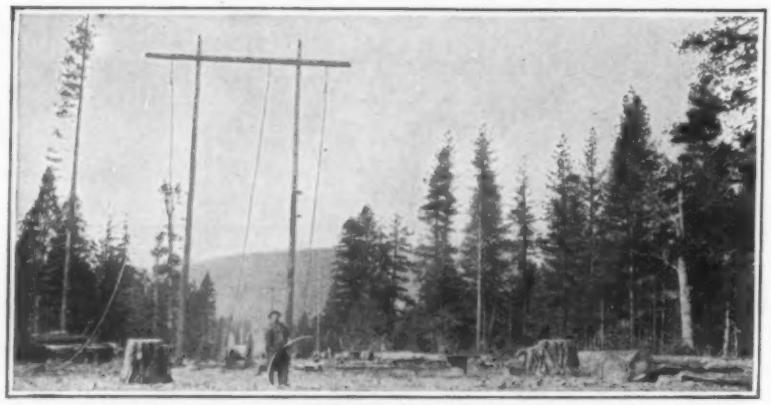
The Superlative in Power Lines

Breaking Records in the Transmission of Hydroelectric Energy

By Charles W. Geiger

ON the new transmission lines of the Pacific Gas and Electric Company two hundred and twenty thousand volts is to be used not merely to break the world's record in high-tension transmission, but to make possible cheaper power for the industries of the West. This super-voltage makes necessary greater spacing between conductors, and consequently higher steel towers, to withstand the tremendous strains of the extra heavy wire required in transmitting gigantic blocks of power generated in the Pit River Project.

The first substation to be constructed for 220,000-volt operation in the world is being built near Sacramento, and serves a dual purpose: to transform the Pit River power from 220,000 volts to 110,000 volts so that it may be distributed to the cities and regions bordering San Francisco Bay, and to regulate the voltage of the power received and thereby secure the most economical transmission and the best service.



A typical pole tower of the sort that is being replaced by steel

The transmission-line connections for the 220,000 volts will include two lines of two circuits, each 201.5 miles long, and made up of 27.7 miles of 518,000-circular-mil steel-core aluminum cable and 172.8 miles of 500,000-circular-mil copper cable. The 27.7 miles of cable is concentric strand consisting of 37 aluminum wires and 19 steel wires, the aluminum being used to provide the conductivity, and the steel wires being used to provide the strength necessary to withstand the weight of snow. The 172.8 miles of copper transmission wire is a rope strand consisting of 49 wires.

The main transformers, high-tension oil-switches, high-tension air-switches and high-tension busses will be installed outdoors. This equipment comprises seven 16,667 kv.-a. single-phase oil-insulated water-cooled auto transformers, 220,000-volt high-tension to 100,000-volt low-tension, with tertiary winding for 11,000 volts for synchronous condensers and with tap for operating at 160,000 volts. One of these transformers is to be held as a spare. There will be a seven-section 110,000-volt double bus-structure, with disconnecting switches; seven 110,000-volt oil-switches; and three 220,000-volt oil-switches.

The steel that enters into the construction of the 220,000-volt transmission-line towers is manufactured at San Francisco, with the following minimum specifications: yield point, 45,000 pounds per square inch; ultimate strength, 60,000 pounds per square inch; and 22 per cent elongation. This product is a carbon steel from open-hearth furnaces. The possibility of producing a carbon steel with these unusual specifications on the Pacific Coast had been questioned and to refute this a test was arranged and conducted at the plant. Samples of steel angles were selected at random from a stock of more than 1000 tons of tower steel of various thicknesses, and tested on a 200,000-pound testing machine. The average of the tests showed that the steel had an elastic limit of 46,800 pounds per square inch by the drop of the beam, a breaking strength of 68,400 pounds per square inch and an elongation of 25.2 per cent.

The evolution of trunk transmission lines has been very noticeable, so much so that we find ourselves asking why the costly galvanized steel tower is taking the place of the inexpensive wood pole. Both the length of line and the amount of current carried have been increased, making it more economical to transmit higher voltages. This has changed the type of insulator from pin to suspension, and necessitated greater distance between conductors which, in turn, has necessitated higher supporting structures and stronger and longer cross-arms.

Insulators have always been a source of trouble, and to avoid this, longer spans were needed. The wood pole was already weak, a 45-foot pole failing with a breast pull of 1600 pounds and very much less when an eccentric or torsional load was applied. The increase in height and the longer arm weakened it still more, and as a matter of safety it had to be abandoned in all high voltage and important lines.

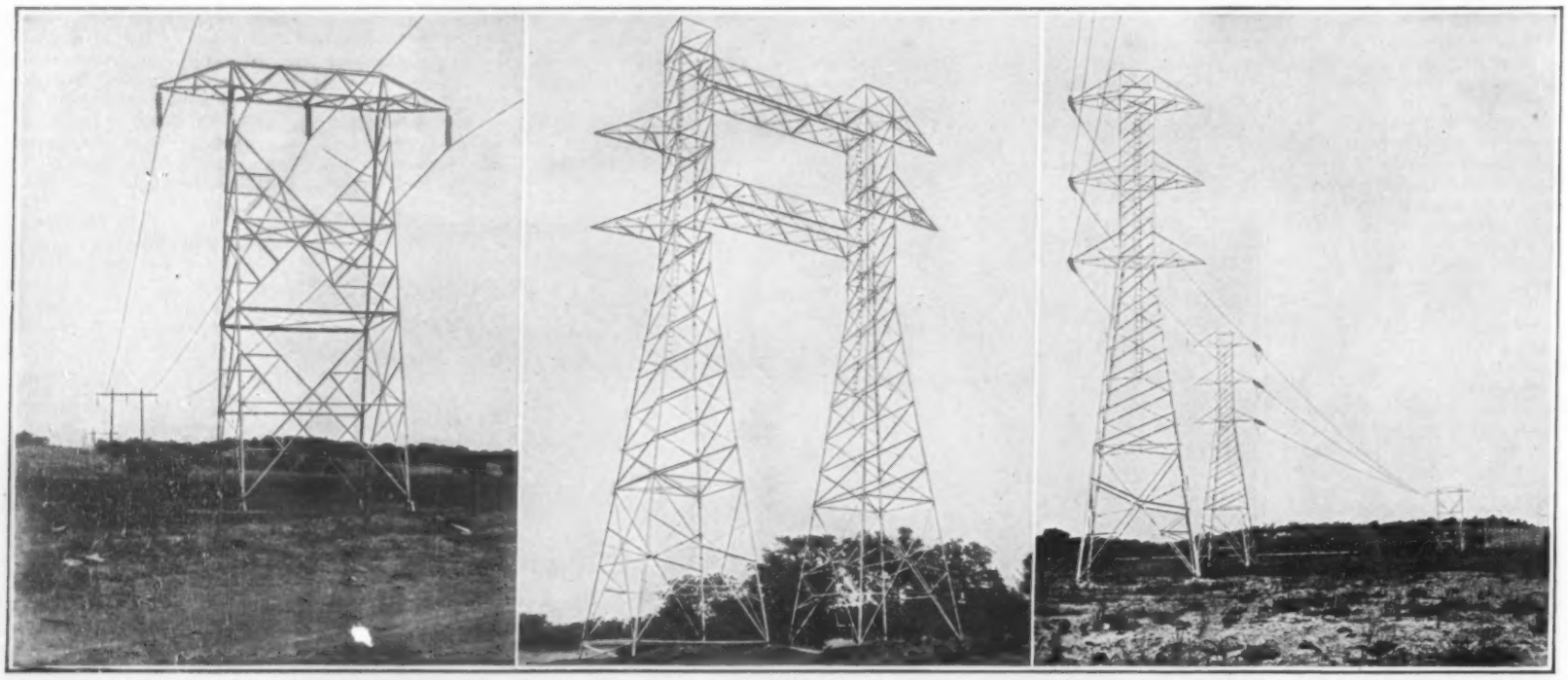
It was therefore necessary to find a material adapted to structures of greater height and strength. Steel is such a material, but owing to its rapid oxidation is not practical without some rust-resisting coat. Galvanizing, giving the best protection known for such purposes and being comparatively inexpensive when its durability is considered, was naturally chosen. The galvanized transmission tower, therefore, was a necessary change demanded by progress, and the wood pole was abandoned in important trunk lines because it was not adapted to the purpose.

The steel towers for the 220,000-volt transmission line are of two types, the snow type and the valley type. The snow towers carry three wires spaced 15 feet horizontally, and the valley towers carry six wires spaced 15 feet vertically and 24 feet horizontally. The valley towers are 97 feet high, weigh 8000 pounds each and are spaced 800 feet. Anchor towers of 12,000 pounds each are placed at all angle points.

As evidence of the unusual merit of the steel used in the towers for the line, the towers were constructed with from 25 to 35 per cent less steel than was thought necessary. Exhaustive tests were made to prove that the steel was strong enough to carry the required load.

The Pacific Gas and Electric Company contemplates the full development in the Pit River Basin from a point on Fall River above Fall River Mills to a point on the Pit below the "Big Bend," a distance along the stream of 60 miles. The total fall is 2104 feet, of which it is expected to utilize 2074 feet in at least five plants. The total continuous power is computed at 320,000 kilowatts, requiring an installed capacity of upwards of 450,000 kilowatt-amperes.

The area of the watershed above the diversion of the last proposed plant is 4809 square miles. The observations of the past 10 years show the minimum daily flow to be 2010 and the maximum 13,300 second-feet. It is tentatively proposed to install a storage reservoir at a point below Pecks Bridge, of sufficient capacity to regulate the river below to such a flow as may be desired. Mass curves indicate that a storage of 62,000 acre-feet will regulate the river to 2500 second-feet in all but exceptionally dry years.



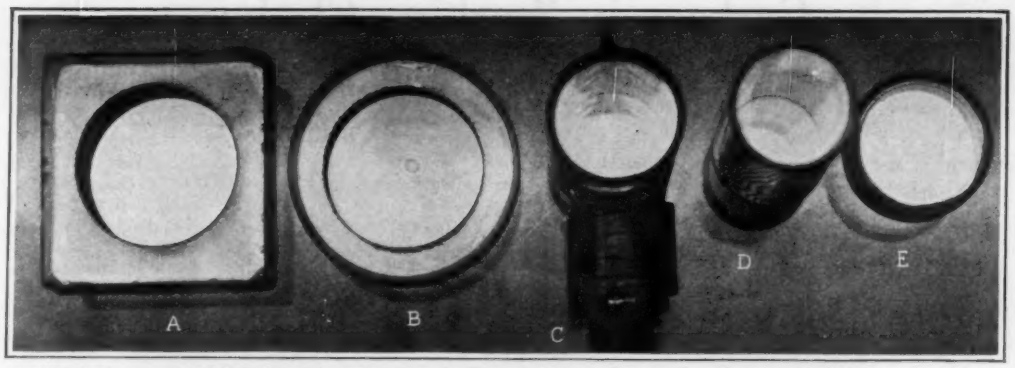
Left: Typical "snow tower," the style used where the weather conditions are most severe. *Center:* The "transportation tower" that occurs once in every six miles. *Right:* The "valley tower" on which one or two ranks of wires are carried, spaced vertically instead of horizontally

Steel high-tension power-line towers of three distinct types

New Method of Fusing Glass

By S. R. Winters

THE discovery of a new and notable method of fusing glass joints without appreciable distortion of the main surface of the glass, is an achievement credited to C. O. Fairchild of the United States Bureau of Standards. The benefits of the scientific contribution may be realized in the welding of glass cells, hollow prisms, glass tubes, lenses, colorimeter tubes, glass boxes, windows of plane optical glass for incandescent lamps, and innumerable articles where the marring of the surface of the glass is to be avoided.



Optical glass welded by the new process. A, B and E are glass cells, C an optical pyrometer, D a simple tube

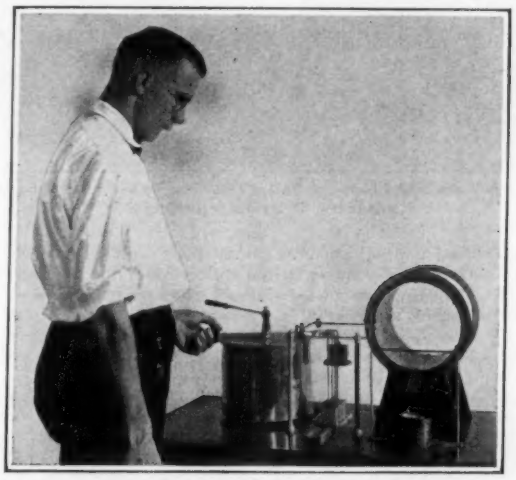
The process involves the use of a specially constructed electric furnace, having a mica window above and a small hole in the side for introduction of a blowpipe. The furnace was equipped with a conveniently-stationed pedestal, extending through a snug-fitting hole in the bottom, the glass specimens being placed thereon and rotated about a vertical axis. A sodium flame supported by an incandescent lamp was used for lighting the interior. This character of flame afforded a one-colored illumination for interference fringes between polished surfaces nearly in contact and the white light supplied illumination of the object. A tiny platinum-rhodium thermocouple, inserted through the furnace cover and arranged so that its hot junction came in contact either with the furnace wall or glass specimens, determined the temperature of the furnace. The blowpipe, previously referred to, having opening of a millimeter, was used with an oxy-gas flame one centimeter long.

The process itself involves the keeping of the glass at a temperature high enough to avoid cracking while administering heat locally. The temperature of the main surface of the glass objects is one in which little deformation will occur. Necessarily, the body temperature is always approaching annealing or red-hot heat. Obviously then, the kind of glass being treated and the size of the object influence the practical application of the new method. The experimental electric furnace permits of rapid heating to the necessary temperature and holding there. The article can be raised to heating strength above the annealing temperature; the blowpipe is then applied, and cooling is started before the glass has opportunity to change its shape. After the blowpipe torch is applied only a few seconds intervene before the welding of the joint is completed.

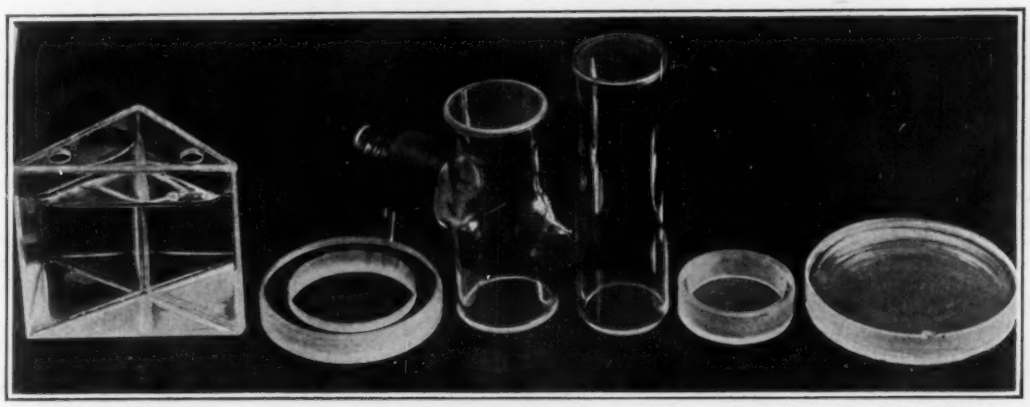
Not unlike other scientific achievements, the discoverer of this process developed the general principle while in search of an improved instrument for a specific undertaking at hand. Then, too, emergency repeated its story of being the mother of invention. The pressing need was for flat glass windows for incandescent lamp bulbs. It was desirable that the glass joints be fused without appreciable deformation of the surfaces. The lamps were needed for studying the effects of diffraction caused by the lamp filament in an optical pyrometer of the so-termed disappearing filament type. Consequently, the initial experiments were conducted with short tubes ground and polished on one end and topped by a flat disc. The tube and disc were given quarters on the pedestal, the temperature rapidly raised slightly above annealing heat, and the flame inserted into the furnace, touching the edges of the disc and tube as the pedestal slowly rotated. The joint was quickly fused. Ordinary American plate glass was subsequently used, the annealing temperature approximating 565 degrees Centigrade.

The triumph of the method is attributable to a happy combination of low thermal conductivity of glass and the swift change in its mobility with temperature. Once heated to its annealing temperature, the movement of glass increases at a rapid rate. To illustrate, certain specimens of glass increase their softness by two for every rise in temperature of 8 or 10 degrees Centigrade. Glass heated to its annealing temperature, or slightly above it, is sensitive to the application of a flame which according to one scientist quickly raises the edge far above the temperature of "upper limit of the annealing range." At the latter point glass is nearly a sticky substance. Thus the union of objects is effected with the utmost ease.

The process is applicable in the welding of absorption cells, colorimeter tubes, glass boxes, polarimeter tubes, Nessler tubes, glass-liquid prisms, lenses, and even interferometer parts. Heretofore absorption cells having cemented sides have included very thick rims for their cementing value. The method unfolded in this story eliminates heavy construction, suitable cells being made with thin-walled tubing. However, a thick rim offers a superior advantage in making cells with quite flat sides. Distortion in some of the objects welded in the preliminary experiments is responsible for this statement from the discoverer of the process: In this way it is emphasized that this new method of joining glass does not require a perfect fit of the articles to be joined and that the final result is measured quantitatively by the lack of fit. Thus, in the construction of various articles the fitting may be perfected to a degree governed by the precision desired; and the flexibility of the new technique seems in fact to constitute one of its greatest advantages.



A new wavemeter of greater range and accuracy



From left to right. Hollow prism, glass cell, optical pyrometer, lamp tube closed at both ends, glass cell with thin rim, compound lens fused at periphery and enclosing an air space

Other articles of the new fused glass, from a different viewpoint

Measuring 65 to 85,000 Meter Wave Lengths

By George Gaulois

AS time rolls on, we become more and more independent of Europe, so far as scientific equipment is concerned. There was a time when we had to go to Germany for our fine radio measuring devices, such as wavemeters for measuring the wave length of apparatus. Now we make our own without hesitation.

Capable of measuring wave lengths ranging from 65 meters to 85,000 or when expressed in terms of frequency, from 3,500 to 4,600,000 cycles a second, a standard wavemeter has been developed by R. C. Cox of the Bureau of Standards. The insistent needs of Government, commercial, and university laboratories for apparatus with a capacity for correctly determining the frequency of rapidly alternating currents are satisfied in this instrument.

The variable condenser, although in principle adhering to a type previously designed by the Bureau of Standards, has been modified in design so as better to serve the specific object outlined. This modified variable condenser shares with other condensers developed by the Bureau of Standards certain outstanding virtues. Among these are: Assurance of constant calibration by its rigid construction, its shield, its unimpeded progress through 360 degrees without "stop-overs" which would jar the plates from alignment. Also, barring air, its dielectric losses are negligible. Large semi-circular plates, unsheared at one edge or rounded at the corners, afford a capacity calibration curve nearly approaching linear from 5 to 170 degrees. Extremely low resistance and correspondingly low power losses of this condenser are guaranteed by the elimination of insulating material other than three short glass rods which act as non-conductors of electricity between the fixed plates and the movable plates and the shield. The topnotch capacity of the condenser is 0.0012 microfarad.

Fixed mica condensers employed are sources of supplementary power. Four shielded condensers are accessible, having capacities of 0.001, 0.002, 0.004, and 0.008 microfarad, respectively. The phase angle of each does not exceed five minutes at 500,000 cycles a second. The high potential terminals consist of rods climbing to the level of the top of the variable condenser, terminating there in mercury wells. Four other units of the latter are projected from the high-potential terminals of the variable condenser. Thus, by means of interchangeable links between the mercury wells any combination of fixed condensers may be placed in parallel position with the variable condenser.

The five coils forming a component part of the wavemeter have, with reference to inductance, a range from 10 to 5,000 microhenries. Electrical factors determined the minimum limitation while the maximum figure was fixed in obedience to mechanical convenience. At present, the Bureau is constructing a coil wound on a skeleton frame resembling the single-layer coils just described, but the unit in the making is composed of three spaced layers and will have an inductance of 23,000 microhenries. For an even higher inductance, a coil bank-wound with high frequency cable wire on a Pyrex glass cylinder, the wire impregnated with collodion, yields 128,000 microhenries.

Resonance is indicated by a single turn of a one-eighth-inch brass rod coupled to the wavemeter coil. The terminals of the loop are in mercury wells fixed at the bottom of an insulating cup. Practice heretofore involved the resting of a sensitive thermogalvanometer in this cup with its terminals merging in the mercury wells. Greater sensitiveness is obtained by exchanging this instrument for a thermo-element with leads to a wall galvanometer. This turn is fixed so that its coupling with any one coil of the wavemeter is unchanged. It is grounded on the side in closest proximity to the condenser.

Garbage in Working Clothes

The Efforts Now Being Made to Get the Value Out of This Municipal Waste

By Harry A. Mount

IF methods of garbage disposal now in use in this country fall short of the ideal, it is not because there has been a dearth of effort to improve these methods. In an article which recently appeared in this journal, the writer showed how plant after plant for garbage disposal had been closed, until we are faced with the threat that the progress of forty years in the art will be swept away by an unfavorable combination of economic conditions.

The publication of this article has evoked a wide range of comment and has brought to our attention no less than six proposed systems of municipal garbage disposal, each of which aims to reduce the heavy loss now involved in disposing of this waste, or actually to turn it into a profit.

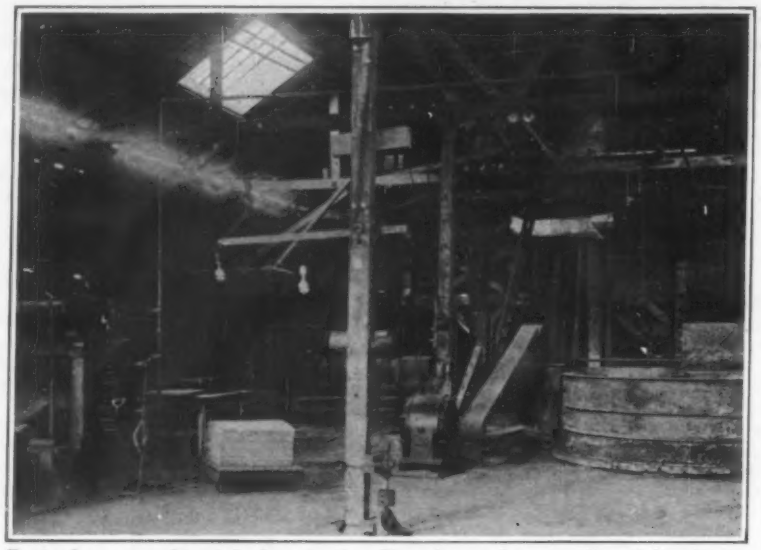
The most widely used of modern disposal systems are based on the idea that garbage contains valuable ingredients which can be salvaged in salable form as greases and fertilizer values. These proposed systems open a much wider field of possible profit from garbage, for it is proposed to manufacture from it such commodities as cardboard, paper, dressings for fabrics and leather, fuel, oils and chemicals.

It is no secret that the garbage collected by every municipality contains raw material for making all of these products and many others. The wonders of modern chemistry make it possible to extract and use them. But the difficulty has been that these materials are not present in sufficient proportion to make their extraction profitable in competition with more abundant sources of raw material. Whether these inherent difficulties have been overcome by the inventors of new processes of garbage disposal remains still for future determination, for in no case where a revolutionary process is claimed has the idea progressed beyond the experimental stage. Until such systems are demonstrated under commercial conditions their value will remain problematical. In one case only there has been such a practical demonstration, and here the aim has been not so much to develop along new and untried lines but to improve an existing method to make it cheaper and more efficient.

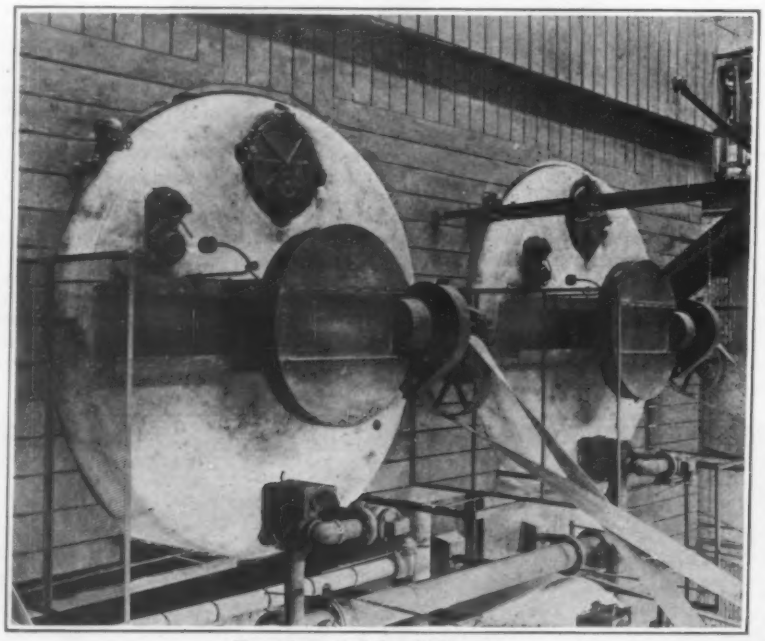
The fact that these new systems have not yet been demonstrated under working conditions, does not mean, however, that they will be of no future value. Perhaps one or more of them will prove a practical solution for what is now a very perplexing municipal problem. It may, therefore, be of interest to report them briefly here.

The statement that five of the six systems have not been tried on a commercial scale ought, perhaps, to be qualified, for one of them, according to its promoters, is being successfully used in several Italian cities. The system was designed by an Italian scientist and had its origin in the custom, on many Italian farms, of dumping all manure, sweepings, dead leaves, kitchen garbage, and like wastes into a bin, where they are allowed to rot and the resulting compost is used as manure. The new scheme consists of building a multiplicity of cement tanks of a definite capacity, each ventilated by a type of condensing ventilator which returns to the compost the materials which would otherwise escape as gases. For a time after the garbage has been placed in the tanks it is kept moist by pumping over it the liquid drained off beneath. It is claimed that during the period of putrefaction the material heats itself to a degree said to be sufficient to destroy all germ life and that at the end of about 45 days there remains only a dry, sterile, and almost odorless compost of high fertilizing value.

Members of a firm which contemplates introducing this system in this country admit that they will have to take into consideration conditions here. The character of American garbage is very different from that of European garbage because American housewives are more wasteful of food and because no plea has been found effective in keeping out of the garbage such materials as bottles, cans, broken glass, bones and old metals. Also, differences in climate may affect the process. Advocates of the scheme claim for it that it can be built as economically in small as in large units, and that disposal stations can be placed about the city so as to effect economy in the collection of the garbage. They say the system is odorless, that no expert labor is required, no power, no careful manipulation. On the other hand, there is the obvious disadvantage that, because of the long time the garbage must remain in the tanks, a very large number of tanks would be required to care for a city of any considerable size, and these would, of necessity, occupy large plots of valuable ground.



Part of an experimental plant in San Francisco, where cardboard has been produced from city garbage



Top view of Cobwell digesters

No attempt is made, under this system, to recover from the garbage any of the values it contains, excepting fertilizer. A San Francisco inventor, however, believes he can make cardboard from garbage at a profit, and has erected an experimental plant where he has turned out small quantities of cardboard, using garbage as a raw material. The process of utilization which he proposes would operate substantially as follows:

The garbage would be delivered to receiving bins, from which it passes to a rotary screen to loosen up the garbage before passing to a conveyor belt. As it passes along this belt men would pick out all objectionable matter such as glass, bones, iron, bottles, wood, tin cans, etc. A hood is placed over this conveyor and all odors are blown to the boiler firebox. From the conveyor the garbage would drop to a shaking screen to remove sand and dust and then would be elevated to bins in the top of the building, from which point it would move by gravity. From these bins the digesters would be loaded, the garbage to remain in these rotary digesters (cookers) for two hours under 150 pounds steam pressure with water. The water, after cooking, would be discharged into shallow pans, from which the grease later would be collected. The plan then contemplates refilling the digester with water, together with the proper chemicals to sterilize and remove all soluble matter, and cooking from two to three hours. The pulp then coming from the digester would be washed in pits and from now on treated as any other pulp for paper-board making, going through beater engine, jordan and board machine.

Experts who have examined this prospective system point out a number of defects. It would be very difficult or impossible to pick from a moving belt conveyor all of the non-fibrous materials in the garbage. Only a minor portion of the grease would be extracted by merely cooking and skimming the waste water. Discharging odors into the boiler firebox would not completely destroy them. These difficulties might be overcome by modifications of the system, but it still remains doubtful whether this source of pulp could compete at this time with our still abundant supplies of wood pulp, although as our natural supply diminishes garbage may become an increasingly important source of paper and paper-board pulp.

Another San Francisco concern has attacked the garbage disposal problem with the idea of obtaining from this civic waste a cellulose product, moludite, which is used as a dressing for fabrics and paper, as a binder for fuel briquettes and for other uses. Says one of the officials of this company:

"One of our processes for obtaining moludite is that produced by ordinary garbage or swill. When we found that we could briquette coal from the moludite obtained from city garbage, it then became a problem for us to work out some satisfactory method of reducing city garbage in large quantity for what was then the sole purpose of obtaining the moludite. We have had specialty engineers at work and feel that we are now about ready to complete a process for the reduction of city garbage, which will do away with fumes, odor, incineration or cooking. It is a simple method and from our research work we are beginning to feel rather elated at our success and expect in the near future to be able to demonstrate a complete unit in operation."

Another claimant for the honor of having successfully solved the problem of garbage disposal is a Washington, D. C., inventor, who proposes to produce a fuel by mixing garbage along with street sweepings and other civic wastes with coal dust, pitch and creosote. It is argued that the civic wastes and coal dust, which is now a waste product at the mines, are now unused materials and that the resultant fuel, in addition to being economical, is equal to the best coal in fuel value, is clean, sootless, clinkerless, odorless, nearly smokeless, and non-coking. It is difficult to see, however, how any value is added to the fuel by the addition of wet garbage. But even if this material can be profitably used, the large amount of coal dust required (45 per cent. of the total fuel tonnage) would restrict the usefulness

of the system to a few cities in or near mining districts. The product would naturally have less value in these regions than elsewhere, and furthermore the plant would have to turn out about double the quantity of fuel in summer as in winter, to prevent an accumulation of garbage. A plant for the utilization of this process has been under construction at Sandusky, Ohio, for about two years, but has never been placed in operation, and no large-scale test has been made. However, a number of stock companies have been organized to exploit the process.

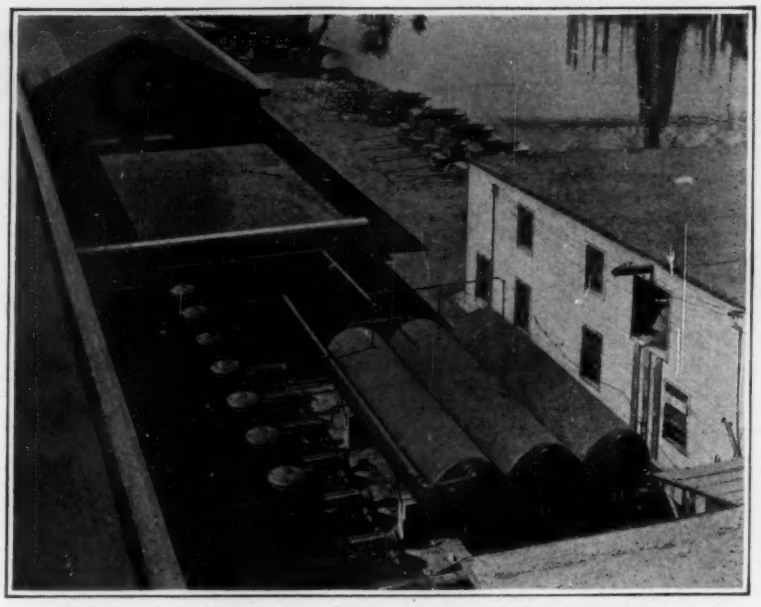
The fifth of the new schemes is destructive distillation, proposed by a New York inventor, and it, like some of the others, has the weakness that it has never been tried on a commercial scale. It is proposed, here, to seal the wet garbage in large retorts and to subject it there to a high degree of heat, sufficient to gasify and drive off the vegetable and mineral oils and many of the chemical constituents. This complex gas goes to a "scrubbing" chamber where it passes through a fine water spray, causing the valuable elements to be precipitated in liquid form. It is claimed there can be recovered in this way not only the vegetable greases, but valuable mineral oils and a long list of chemicals, and, in addition, there will remain a gas which can be used under the retorts. Thus the system provides that the garbage destroys itself, after only an initial heating. If it is found that this cycle is really practicable, the fuel economy will be a powerful point in favor of the proposed system.

Of greater interest, perhaps, from the practical standpoint of the city official faced with a garbage disposal problem which waits neither on science nor finance, is the development of a device reported briefly in our former article. This was the discovery by Dr. Yandell Henderson of Yale that odors which could be passed through a stack, or otherwise confined for a short time, could be "gassed" and completely destroyed. The active agent is the greenish vapor, chlorine, with which the Germans introduced chemical warfare.

This new development has been a modification of the Cobwell process of garbage reduction, to make it more economical. This process, which is a development of the past few years, meets in an ideal way all of the requirements of a good reduction process, excepting perhaps the matter of cost. The process is sanitary, odorless and it recovers the grease and fertilizer values in their best form.

We related in the former article how the garbage reduction plant at New Bedford, Mass, in an attempt to reduce its costs, had used garbage tankage as fuel under the boilers and that odor from such burning caused the scheme to be quickly abandoned, so far as this particular detail is concerned.

At New Bedford the Cobwell system is used. In this process the garbage is dumped into reducers and this is covered with a solvent, gasoline. The reducer is steam-jacketed and by means of steam heat the gasoline and water in the garbage is slowly boiled away. This step dehydrates the garbage, releases the grease and at the same time renders the material sterile and inoffensive, the full period of operation requiring from 12 to 18 hours. After the cooking or dehydrating period the supply of steam in the jacket is cut off and the remaining solvent, which carries the grease, is withdrawn through a strainer in the bottom of the tank. The mass is then flushed two or three times with fresh solvent to remove any remaining grease. The steam is then turned on again to heat the tankage and drive off in the form of vapor the remaining solvent. The brownish granular mass that remains is withdrawn through a door in the side of the tank and is ground for use as fertilizer. The solvent carrying the grease is piped to stills, where the solvent is evaporated by steam heat and only the grease remains.



Condensers and solvent storage tanks of a typical Cobwell garbage-reduction plant

The solvent vapors in each case pass through condensers and then flow back to storage tanks in a liquid state. But notwithstanding the greatest care an appreciable amount of the solvent is lost. It was believed that if the time of dehydration could be reduced, less solvent would be lost and less power used. Having been assured that the obnoxious odors from the drying of garbage could be destroyed by the use of chlorine gas, the New Bedford city officials purchased and had installed a direct-heat rotary-type dryer and this is now used to evaporate the bulk of the moisture contained in the raw garbage before it is put into the Cobwell reducers. This has resulted in reducing the cooking or dehydration period to three hours, at once greatly reducing the solvent loss and fuel consumption and doubling the capacity of the plant, without increasing the labor required or the loss of by-products to be recovered.

The use of direct-heat rotary dryers for the drying of garbage is not new and was known to be economical, but was practically abandoned years ago because of the offensive odors generated by heating the material to high temperatures. In the case of New Bedford, the vapors or odor-bearing gases are passed through a mixing chamber where they come in contact with the chlorine gas injected by the Henderson-Haggard deodorizing process, and when discharged into the atmosphere no noticeable odor is present.

It has been suggested that this experience will be of value to many cities which have outgrown garbage disposal plants of this general type, as well as to cities operating such plants at an excessive cost.

The reducer room of a large garbage-treating plant

The Nature of Soil Fertility

THE problem of maintaining the fertility of our richer agricultural soils and of improving that of the poorer ones is one of ever-increasing importance. Soil fertility, however, is often spoken of as though it were an absolute property of a soil: it is not always sufficiently emphasized that fertility is a particular relationship subsisting between *soil conditions* on the one hand and *crop growth* on the other. The particular conditions that conduce to soil fertility are the resultant of two main groups of factors: the *infrinsic* properties of the soil, which are dependent on the actual chemical and physical and biological nature of the soil complex; and those *extrinsic* properties which are impressed on the soil by topographical and climatic factors. These two groups cannot be sharply distinguished from each other, nor can any hard and fast line be drawn between the various chemical, physical and biological factors comprised in them because few are at present susceptible of any exact measurement. In other words, that particular group of conditions that make up the fertility of any particular soil is an *equilibrium* caused by the interactions of numerous factors, some of which can be varied by the agriculturist by manurial and cultivation operations. It is by these operations (knowledge of which has been evolved empirically throughout the ages) that the farmer is enabled to maintain or to change, or to regulate and adjust the relationships between soil conditions and crop growth.

Among those soil factors that are most readily susceptible of regulation and adjustment are many that cannot be allowed to vary beyond comparatively narrow limits without becoming limiting or controlling factors in crop production. The capacity of the soil to supply the necessary nutrients for plant growth is of fundamental and obvious importance; the original reserve of foodstuffs, supplemented by biological activity of the soil organisms, is insufficient, and must be aided by addition of natural or artificial fertilizers. The complexity of even a single factor such as this is evident when it is remembered that the very poorest of soils apparently contains sufficient nutrient material for many hundreds of crops, and the rate at which the potential foodstuff is made available for the plant is apparently of more importance than the actual amount of nutrient material present. The micro-organic population of the soil is also of supreme importance, and not merely as food producers, although the conditions governing the equilibrium between the various genera and species form an almost untouched field of work. The relation of the soil to air, water, and temperature forms another group of limiting factors of no less interest and importance than the others. All these and many more are intimately related and mutually dependent—the simple addition of a few cwts. of soluble fertilizer means far more than a mere trifling addition to the store of plant food in the soil, for such an addition is followed by an alteration in many physical and biological properties of the soil.

Anything that produces an alteration in any of these numerous and mutually dependent factors will have its effect also on many of the others, and the complex system of equilibria existing or tending to exist in the soil will be disturbed. In particular the growth of soil organisms, as well as that of the plant itself, is very sensitive to the reaction of the medium, and it frequently happens that the presence or absence of a base will act as a limiting factor in crop production not merely through the effect of acidity or alkalinity on the plant itself, or on the soil organisms, but on account also of the varying displacements produced on all the elaborately interrelated factors that go to make up the complex chain of soil equilibria.

This view shows an upstream channel mat of woven willows being sunk in position for bank protection

Curbing the Mississ

Levee Construction the Only Practical Method for

By J. E. Walker

THE Mississippi Valley, from Cairo to the Gulf, has recently passed through the most trying and dangerous experience in the history of its long struggle with the flood waters of the great Mississippi River. The distance by the tortuous river is about 1000 miles, and for long stretches of this distance the inhabitants on either bank have been threatened in the spring of every year with heavy inundation, accompanied with the loss of life, the sweeping away of homes and farm buildings, and of crops and livestock.

It was inevitable that the early settlers in the Mississippi bottom lands would make some effort to protect themselves against this ever recurring peril; but it will be news to many of the readers of the SCIENTIFIC AMERICAN to learn that as far back as the year 1717 the early colonists were attempting to control the floods by building levees, or artificial embankments, outside the river banks. Within the next hundred years or so the work was carried on so far as the means of the country permitted, and by 1828 the levees had been extended up the left bank of the river to Baton Rouge, and along the right bank as far as the mouth of the Red River.

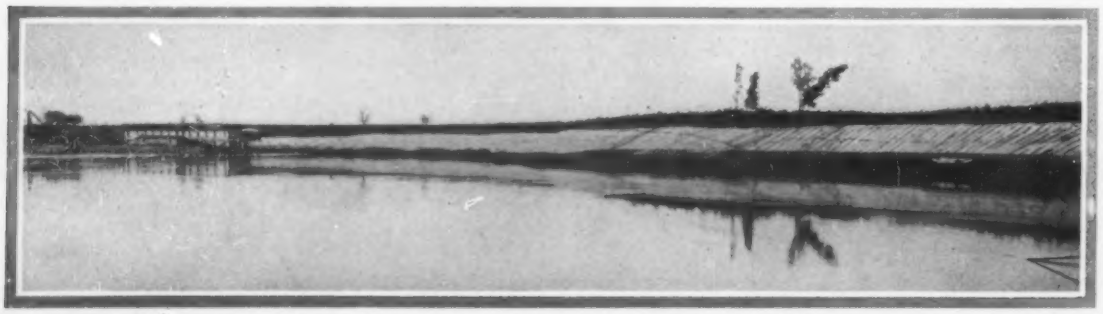
Finally the Federal Government came to the assistance of the local communities in this unequal combat with the mighty forces of the river, and in 1850 all the unsold swamp and overflowed lands below the Ohio were granted to the several States along the Mississippi; the object being to raise a fund for reclaiming the lands that were subject to inundation. Under this stimulus the construction of levees was carried forward more rapidly; and by the year 1860 all the basins of the great delta were provided with stretches of levee covering the most exposed positions, and, therefore, possessed a certain degree of flood protection. This levee work, it should be understood, was not comparable to that which exists today, the average height being only about four feet as compared with the present average height of 18 feet.

However, under the stimulus of the sale of swamp and overflowed lands, the work was carried on with more or less continuity until the year 1879, when the Federal Government, realizing that this big problem could be solved only after a thorough study of the problem by competent engineers and by cooperation with the several States affected, created the Mississippi River Commission. This commission was instructed to make surveys and draw up and put into execution plans for the improvement of the river; they were to "correct, permanently locate, and deepen the channel and protect the banks of the Mississippi River, improve and give safety and ease to the navigation thereof, prevent destructive floods, promote and facilitate commerce, trade, and the postal service."

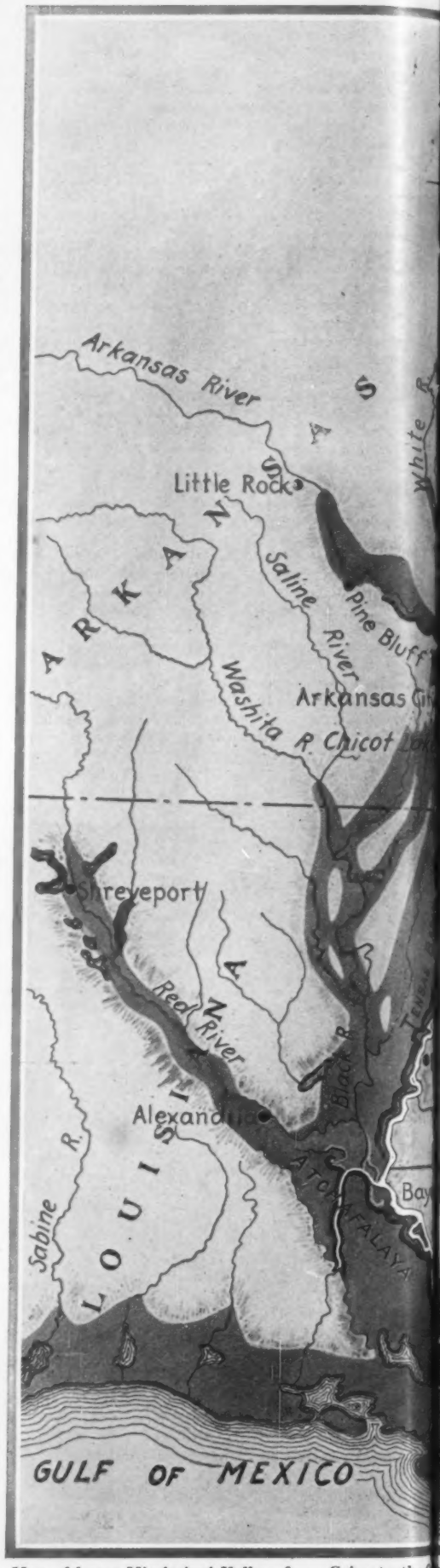
Before passing on to consider the work which has been done and which now is being carried on by the Mississippi River Commission it would be well to consider the vast extent of the United States that is included within the drainage basin of the Mississippi, which has a total area of 1,240,050 square miles. The eastern boundary line reaches into western New York, south of Buffalo; the extreme western boundary is found in Montana, west of Butte; the northern boundary reaches 70 miles to the north of the boundary line between Canada and the United States, and the southern boundary is formed by the shores of the Gulf of Mexico. The drainage, or run-off, of 30 out of 48 States empties into the Mississippi. The basin measures 1822 miles east and west, and 1449 miles north and south. That the Mississippi below Cairo has a tremendous task to perform in conveying the spring freshets to the sea will be understood when we state that over this great area of nearly one and a quarter million square miles the average annual rainfall is about 30 inches. As a matter of fact, when the river has risen to the top of its banks it can carry only about one-half of the maximum flood discharge, which at the upper end of the delta is about two million second-feet. The volume of water can be visualized, also, when it is stated that the extreme rise of water, from low to high, reaches 60 feet at Vicksburg and Arkansas City.

Now, when the Federal Government took hold of the problem through the Mississippi River Commission, there was a large amount of dissatisfaction with the levee system as such. The local authorities were naturally disheartened by the many and continuous ruptures of the levees, followed by disastrous loss of life and property. During the years 1881, 1882 and 1883, in which there were heavy floods, the levees were broken in no less than 712 places. The opponents of the levee system claimed that, as the levees were carried up, the deposits of silt caused the bed of the river to rise also. The fallacy of this was proved by extended investigation, which showed that there had been no such progressive elevation of the bed of the river. Indeed, the latest data proves that where the river is reenforced by levees of adequate height, there is a tendency for the river to enlarge its cross-section and lower its original bed. It should be mentioned here that before any attempt was made to control the Mississippi, its floods extended for a width of 60 miles, and the annual floods, as they overflowed the river channel, deposited most of their silt near the river banks; with the result that there developed a slope of the land away from the river of from 3 to 15 feet per mile. Consequently the drainage would be from the river toward the bordering higher land, where it flowed into various streams which emptied the overflow into the Mississippi, when they joined the main river.

From the time when the commission was formed, down to the present day, there has been a steady rapid-fire of criticism directed against levee construction as such. This criticism was most vigorous after the floods of 1881 to 1883, and was due, as we have said, to the large number of breaks which had occurred in that period. On the other hand, all competent engineers have realized that levee failures have been due to the fact that the early structures were more or less of a makeshift character, and were not based upon that exhaustive study of the problem which must ever underlie successful engineering works. The engineers of the commission, that is the Engineer Corps of the United States Army, endorse the levee as being the only practicable solution of Mississippi flood control; but they are careful to point out that levees can be completely successful only when they are of sufficient height to overtop everywhere the maximum flood stage, and only when they are built to a pre-determined width



Completed bank revetment at Valewood, Miss. The bank is paved with reinforced-concrete mat units of the kind shown on page 110

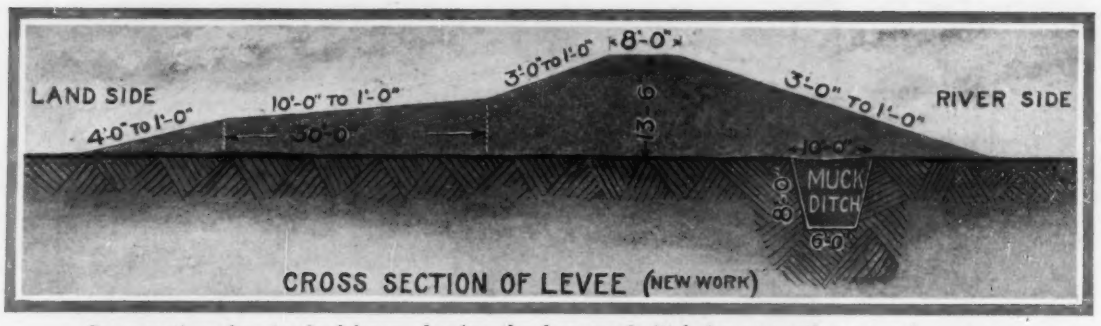


Map of lower Mississippi Valley, from Cairo to the Gulf, showing by shading and in heavy black lines the existing levees, which are over 500 miles

ng the Mississippi

acticable Method for Restraining the Flooded River

By J. E. Walker



Cross-section of a standard levee, showing the deep muck ditch for preventing ground seepage

and slope, and are protected on their river side with some form of anti-scour protection.

Several alternative schemes for river control have been suggested. There is the plan for bypassing the flood waters through artificial canals paralleling the river; a scheme which might relieve the stretch of land through which it was cut, but would do so by producing more troublesome floods below the point at which the canal re-entered the river.

Then there has been a great deal of unconsidered speech and writing in advocacy of the construction of reservoirs in the upper approaches of the river, in which to impound the floods and release them gradually without damage to the country below. Now, in the first place, there are no natural basins, with narrow outlets suitable for dam construction, to be found in the upper reaches of the Mississippi basin, and in the lower reaches of the river and its tributaries, the construction of such reservoirs would not only be prohibitive in cost, but, indirectly, they would flood some fully settled communities and involve the blotting out of large sections of valuable farm land. As a matter of fact, it would be a physical impossibility, and certainly an economic impossibility, to hold back these flood waters by any system of reservoirs. At the National Drainage Congress, held in St. Louis in 1913, Col. C. McD. Townsend, U. S. A., then president of the Mississippi River Commission, presented a graphic statement, showing how the floods on the lower Ohio and Mississippi Rivers are due to rainfall upon their lower tributaries, rather than upon the distant head-waters in the mountains, where the advocates of reservoir control proposed to store the water.

He showed that in the great Ohio River flood of 1913 the city of Cairo, at the junction of the Ohio and Mississippi, was so threatened that women and children were sent away and the city was more than half depopulated. The crest of this flood reached a greater height at Cairo than any before recorded. Suppose there had been a huge storage reservoir available, not merely on the head-waters of the Allegheny and Monongahela, but at the city of Pittsburgh itself. Suppose there had been another such huge reservoir at St. Paul, Minn., capable of taking all the flow of the upper Mississippi. Suppose another had existed at St. Joseph, Mo., sufficient for the whole flow of the Missouri.

The length of time required for a flood wave to pass down stream from these several points to Cairo is known. Suppose, therefore, said Col. Townsend, that in order to protect Cairo and the lower Mississippi Valley from the recent flood, the gates of these reservoirs had all been closed, so that not a drop of water would have been allowed to flow past Pittsburgh or St. Paul or St. Joseph, until the floods would be too late to meet the flood from the lower Ohio tributary and add to the volume at Cairo. In spite of this restriction the flood flow of two million cubic feet per second, which the river at Cairo attained as its record height, would have been diminished by only 35,000 cubic feet per second by such reservoirs. That is to say, it would have been diminished by less than 2 per cent of its total volume.

So much for reservoir protection.

Thanks to the cooperation of the Federal Government with the various States, the Mississippi levees are now completed to standard height and width for about 500 miles. The whole length of the levee line has been built up to a level that will withstand the normal floods. From now on the work to be done consists of completing the levees to standard height, width, and cross section.

Much has been heard naturally of the recent breaks in the levees at certain points, with the usual resulting losses; but it is a matter for congratulation and confidence that no break occurred in those portions of the levee which had been carried up to grade on the standard cross section determined by the Army engineers who have this work in hand. Ask any of the Army Engineer Corps who are concerned in levee construction, whether they are satisfied with the way in which the work stood up against the highest flood on record, and they will tell you that they are more than satisfied, and that they have the fullest confidence that, when the work is completed, such a thing as disastrous overflow of the Mississippi River will be extremely unlikely is not impossible—provided, of course, that every care is taken to maintain the work in first-class condition.

A levee is a simple earth embankment located generally at a considerable distance inshore from the river bank; its exact location being determined by the topography of the ground and by the lay of the river, and general flood conditions. Construction is carried on by excavating the material from borrow pits located usually on the land side of the levee, and it is done by the use of the scraper and other customary methods for such work. The cross section of a standard levee is shown in the accompanying illustration. It has a width of crown of 8 feet, at a height 3 feet above the highest flood stage. The sides have a slope of 1 to 3, supplemented on the land side by banquettes 20 feet wide for levees from 10 to 13 feet high, 30 feet wide for levees 13 to 16 feet high, and 40 feet wide for levees more than 16 feet high, the tops of the banquettes being from 5 to 8 feet below the top of the levee.

To protect the levees from erosion by rain they are sodded with Bermuda grass. They are protected against the wash of waves by a layer of 4 inches of concrete, or by a board protection.

We show illustrations of the methods of revetment which have been developed as a protection against bank erosion. There are three types—the willow mattress, the articulated concrete mat, and the solid concrete mat. In the articulated type each unit is 3 inches thick, 11½ inches wide, and 3 feet 11 inches long, the whole being reenforced with 12-inch wire mesh. Solid concrete mats are 50 feet by 150 feet in area, and 3 inches thick. They are launched and sunk in a semi-plastic state by pulling the launching barge out from under.

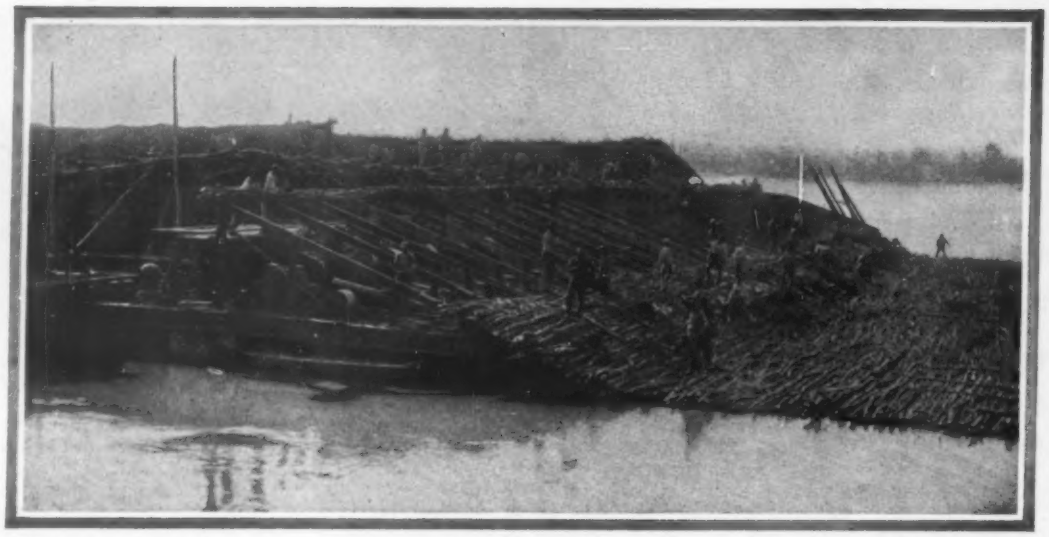
The question of when this great and urgently-needed work will be completed is not one of engineering; for the Army engineers have solved the technicalities and demonstrated the complete efficiency of their methods. It is a question of the provision of the necessary funds; and this is for Congress and the several States concerned to decide. The present program is the appropriation of $45,000,000, to be available in annual installments of $10,000,000, these moneys to cover the control of the Mississippi and also of

ing by shading the areas originally subject to flood, h 500 miles are completed to full height

Here we see a dragline levee-building machine at work. In the foreground is a stretch of old levee, grass-covered for protection against washing away by heavy rain

the Sacramento River, California.

Such, in broad outline, are the Missippi Flood Control problem and the approved means for its solution. It is not claimed that the latter are absolutely final. Each year's experience suggests new appliances, such as the concrete mats above referred to; and in a later issue we shall return to this subject with the presentation of a new type of brushwood or tree dyke, designed to make the river build up again, by silting, stretches of land which have been washed away.



The fascine protecting mats are woven on inclined grids; and here we see a mat that has just been launched

Conquering the Dome of the World

NEWS travels very slowly through the vast passes which surround the virgin mountain of the world—Everest, but the reports are more than encouraging, and possibly by the time that our readers scan this printed sheet the great adventure will have been terminated. Communication seems to take about twenty-five days to Simla, but once within the reach of the telegraph and the cable the whole world is supplied with information within a few hours.

The conquest of Mount Everest is perhaps one of the three or four greatest sporting events that the world has ever known, and here sport is used in its widest and grandest sense. Few events are comparable to it. Perhaps the discovery of America and the North and South Poles may be likened to it for interest. The reconnaissance of last year laid a scientific foundation for the events which have been transpiring so swiftly amidst the great mountain solitudes. A few days ago the cables published a dispatch from General C. G. Bruce, C.B., Leader of the Expedition, which was cabled over and published in the newspapers in this country. This dispatch, announcing the highest altitude ever reached by climbers on the surface of the earth, read as follows:

"Three members of the Everest expedition, Mallory, Somerville and Norton, on May 21 reached an altitude of 26,800 feet, the highest ever reached by man, and just 2200 feet below the summit.

"The news came in three messages, which reached London from Gen. Bruce, commander of the expedition. On May 21 the three members named, leaving the camp established on May 21 at 25,000 feet, climbed nearly 2000 feet, and on the third day were back at what is known as Camp Three at Changtse, 21,000 feet above sea level and three miles northward of the summit of the peak.

"To have got so far in a climb which was merely a kind of preliminary reconnaissance is a very fine achievement and seems to augur well for the success of the final effort."

The London *Times* notes that the point reached, which is about 2200 feet below the summit, exceeds by almost the same margin the previous world's record of 24,533 feet by the Duke of the Abruzzi in 1910, and adds: "The prospect of reaching the summit seems now much less a forlorn hope than it did."

Referring to the preliminary climb of nearly 20,000 feet, the London *Times* says: "In these tremendous altitudes, more especially as they did not use oxygen, this must be looked upon as pretty good going. If a further camp can be established at or about the extreme height already reached, it seems well within the bounds of hope, given absence of violent winds and blizzards, that the final object will be reached. Judging by General Bruce's dispatches, the whole organization has worked perfectly."

The London *Times* proceeds editorially: "When we last heard from him, on April 12, they were at Kampadzong, whence they continued on the exact route of Howard Bury's expedition until they reached Shekardzong, fifty or sixty miles slightly to east of north of Mount Everest. Thence, instead of going further west to Mengridzong, as did the expedition of 1921, they turned nearly due south to Rongbuk. General Bruce therefore determined to make an attempt from the north up the Rongbuk Glacier instead of from the east by the Kharq Valley.

"It is, as he says, doubtful whether so big a caravan, consisting of thirteen British, over sixty hill men and 350 animals, besides porters, has ever before been established so high as the base camp at Rongbuk."

Writing from the Rongbuk Glacier Camp, 16,600 feet, General Bruce says that low night temperatures at the camp were 25 degrees and that frost continues even at the date he wrote, May 14th. The monsoons begin early and usually last until late, so that explorations can only take place during the summer months.

The natives offer abundant material for study. Colonel Bury talks very interestingly of them: "They had been informed by the Dalai Lama at Lhasa and the Tashi Lama, the religious head at Shigatse, that the expedition was on foot, and letters had been sent to the Governors of all districts through which we were to pass, saying that what help could be given us should be given. These instructions were carried out to the full, and we were shown the very greatest kindness. It must be remembered that these Tibetan people had never before seen a European.

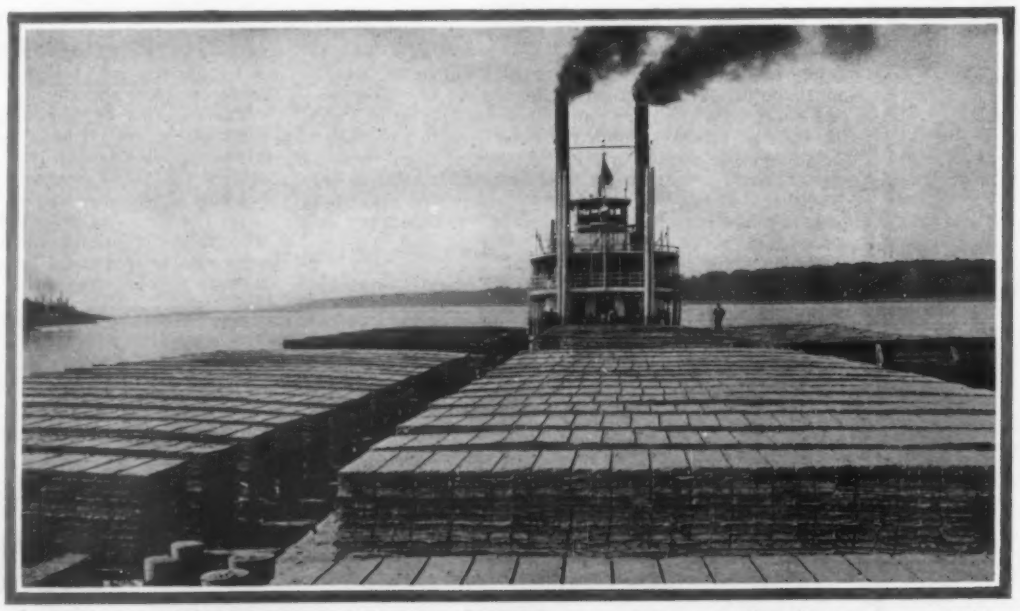
"Photographs impressed them most. These and a camera they had never seen before. They took a huge delight in being photographed, and nothing pleased them more than being given a copy of the picture. There was an old man, a very old man, in fact, the head abbot of a monastery at Shekar Tchöde. He was a reincarnation—these people all believe in reincarnation—and we took a photograph of him. A hundred miles from the monastery we were asked for copies of that portrait. No present was so acceptable, for the people worshipped the abbot as a holy man, and the photographs of him we gave them they put in their shrines.

"They are strangely ignorant of the country outside the district they live in, as we found when we sought information about routes. You might hear in one spot three different stories of the whereabouts of the same place. This kind of thing added much to our difficulties, especially as our maps were inadequate.

"One of the oldest customs is that here they never bury the dead. In each village you find a couple of men who are butchers. When a death occurs they are called in and cut up the body in small pieces, which are thrown to the birds.

"The people suffer a good deal from ophthalmia and cataract, owing to the wind and dust. They have, perhaps, one bath a year in the hot springs, which is generally taken just before the winter. The women smear their faces with grease and soot to protect the skin against the weather. The people practice polyandry. The wife of the eldest of three brothers, say, belongs also to the other two. If the second marries also, his wife belongs to him and the youngest brother. If the third weds, he has his wife to himself. So it pays in Tibet to be a youngest son. The eldest is considered to be the father of all the children. The food is a sort of macaroni, made of wheat flour from the Brahmaputra Valley, mince, chili, dumplings, and tea made with butter and salt. There is also brewed a sort of barley beer called 'chang.' After the harvest had been got in I once saw an entire village get utterly incapable on this drink."

Colonel Bury declared that in the Kama Valley there was quite the finest scenery he had ever seen anywhere in the world. From Everest and other mountains there descended sheer into the valley cliffs of 10,000 feet. There were trees and bushes in luxuriant profusion growing right up to the ice line, thanks to the moist air; and lower down there were dense forests of conifers. This vegetation was colored in the softest shades, and above it stood out the peaks clear-cut against the blue sky. "The moist air produces most wonderful effects in color at sunrise and sunset, and so clear was the atmosphere that one could see far-distant views. Violet and orange were colors that added to the beauty of the spectacle, and sometimes one could see from a high point over a sea of cloud for 100 miles. It made one feel a very insignificant atom in a vast world of wonderful beauty."



The U. S. towboat Issaquena, with a tow of 100,000 square feet of reinforced-concrete mat slabs and 500 tons of gravel

The recent bulletin from Mount Everest relieved the anxiety which was beginning to be felt for the Everest expedition and raised hopes of success among members of the Royal Geographical Society who have been doubtful whether human beings would be able to live at such an altitude as the summit of Mount Everest.

They were astounded to learn from General Bruce's brief dispatch that three of the party had been able to climb within 2200 feet of the summit of Everest and more than 3000 feet higher than did any member of the previous expedition and without the aid of oxygen. With the ample stores of oxygen at hand it seems very probable that the final conquest of the greatest mountain on earth will soon be an accomplished fact. But success must be immediate; one authority claims there is only one month of suitable weather.

Sand Fence of Old Cross-Ties

AMONG the sand dunes of Michigan, at New Buffalo, it was found very difficult to keep the railroad tracks above ground. Ultimately a sand fence was built of cross-ties, in the manner pictured, and this served the purpose admirably. In the course of time a heavy dune has been formed against the fence, which is actually submerged at its middle point; and the greater permanency given to the surface of the dune by the retaining fence has induced a certain amount of vegetation, which goes further in the direction of keeping the sand in place.

Using old cross-ties to protect the right-of-way from the shifting sands

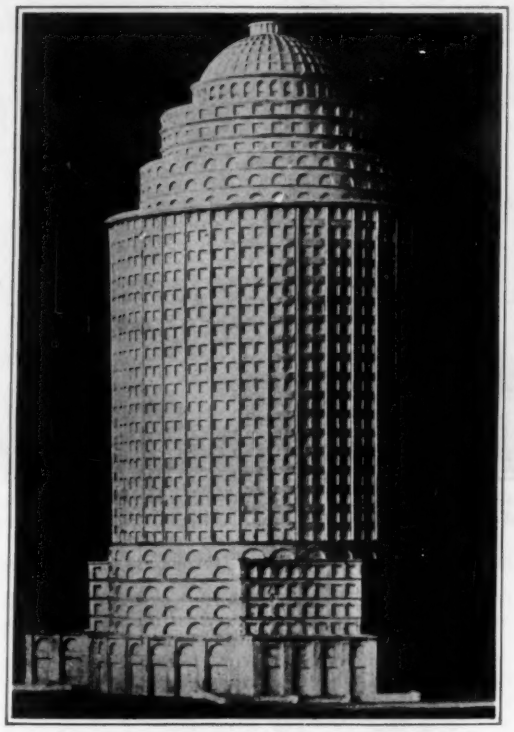
Germany's Forthcoming Skyscrapers

AMERICA'S skyscraper type of city building, heretofore never to be sufficiently scorned from the European viewpoint, is catching on in Germany. It appears that several of the Teutonic cities are beginning to feel the pinch of land values, and are meeting the situation just about as it has been met in American centers of population—suggesting that human nature is fairly constant after all, in spite of national antipathies of one sort or another.

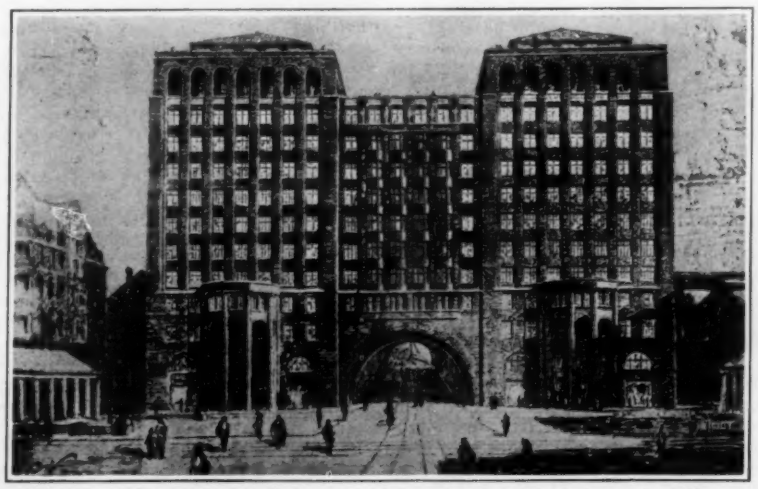
Cologne will apparently be the first German city to have a genuine skyscraper on the American plan—on the American plan even to the passage through the two lower floors of an archway to carry the street which the structure will straddle. In its general architectural effect an effort seems to have been made to hold the new building in keeping with the city hall and other old landmarks near which it will stand; but the skyscraper lines are there too, unmistakably.

Somewhat more startling is the building planned for Leipzig. We are not aware of laws here which restrict the height of buildings over certain percentages of the lots on which they stand, and infer that the terraced effect is purely an architectural one, and in no sense forced upon the builder by external regulation. This tower building will be thirty stories high and 360 feet tall. It is the plan to put it up in six sections, as funds become available, each designed to support the whole weight which will ultimately be piled on top of it.

Both of our views, of course, are drawings made from the plans, and not photographs. At last accounts, work of actual construction had been started on neither of these buildings.



A thirty-story tower building of unmistakably American style projected for Leipzig



Cologne's forthcoming skyscraper, on somewhat less severely modern lines than the Leipzig specimen

The Romans Made Soap in Pompeii

ABOUT 5000 to 6000 years ago there existed an ancient and highly developed civilization in the island of Crete, whose chief city was called Cnossos. Our knowledge of early Cretan life and culture is very limited, due chiefly to the fact that the Cretan language, as represented in the sculptured writings left us, is one of the few languages that scientists have been unable to decipher. But, in the ruins of this very old city there has been found a bath-tub, much like the kind that is used today.

So, the belief that "cleanliness is next to godliness" has apparently an ancient and honored origin. Soap too is of ancient lineage, but the very early civilized nations did not know it. They used instead the juices of certain trees and fullers' earth as cleansing agents. Fullers' earth is also called infusorial earth and is the remains of minute diatomaceous animals. It is found in the earth at certain places. This substance was spread on the clothes and stamped in with the feet.

Soap was undoubtedly made by the Romans in Pompeii, for in the ruins of this city there is found the remains of a soap-maker's shop. During the eighth century soap was made in Italy and Spain. The first real soap works was established at Marseilles in France in the twelfth century, when olive oil was first employed for the purpose of soap making. Soap was introduced into England in the fourteenth century.

When our mothers used to collect the fatty refuse from the kitchen and treat the same with a strong lye in a kettle, heated on the stove, they employed fundamentally the same process of making soap that is now used in the large industrial plants on a more developed and scientifically controlled scale. There are quite a few different kinds of soap, but they are all made basically on the same principle, that is by the action of lye on fats, oils or grease. The result of this treatment is the formation of a solution of the fat in the lye, but the fat is no longer present as such but has combined with the lye to form soap and there is liberated at the same time an oily substance which is called glycerine.

The soap is separated from the glycerine by the addition of salt, and the salt solution containing the latter is drawn off and distilled to recover the valuable product. Glycerine is useful for many purposes in medicine and industry. It is employed in the explosive industry to make nitroglycerine, which is used as such in the shooting of oil wells and in a far greater amount in admixture with various absorbent substances, such as flour, sawdust, wood meal, etc., in the manufacture of dynamite and other commercial explosives.

The soap is then subjected to a boiling process, generally with the addition of oil or rosin to increase its lathering properties and make it softer. Oil is used for toilet soap and rosin for laundry soap. After the boiling has progressed for some time, the soap becomes very thick. The soap is then allowed to settle for about a week, whereat the good soap rises to the top and the bad soap, which contains a large amount of alkali, settles to the bottom. The soap is then put in a mixing machine and mixed with various substances such as perfumes, borax, starch, grit, talc, etc., which give it the characteristic odoriferous and physical properties of the thousand and one soaps found on the market today.

The care with which the soap is made, the attention that is given to the completeness of the removal of the alkali used in its manufacture, as well as the nature of the raw materials, determines the use to which the soap may be put. Fine toilet soaps are made from better stock than laundry soaps. Soft soap is made with potash lye instead of soda lye and fats which are high in oils. The sort of soap that remains liquid and is drawn for use from a special container is made by adding glycerine or alcohol to soft soaps. Cocoanut oil is used largely for this purpose. Floating soap is made by pumping the soap mixture full of fine air bubbles before it is cast into molds. Castile soap is made from olive oil, mixed with linseed oil, cotton seed oil or corn oil to keep it from getting brittle. The transparent soaps are made by dissolving a good grade of soda soap in alcohol.

The Odorous Constituents of Peaches

AS a result of their investigations on the odorous constituents of peaches, Messrs. F. B. Power and V. K. Chesnut conclude (*Journal American Chemical Society*, 1921):

The odorous constituents of the peach may be said to consist chiefly of the linalyl esters of formic, acetic, valeric and caprylic acids, together with a considerable proportion of acetaldehyde and a very small amount of an aldehyde of higher molecular weight. It is probable that the volatile acids are present to some extent in a free state.

A minute amount of acetaldehyde is contained in the emanation from the entire ripe fruit.

No trace of hydrocyanic acid or benzaldehyde could be detected in the distillate from peach pulp. It may therefore be concluded that the occurrence of the glucoside amygdalin is restricted to the kernels of the fruit, and that no other compound capable of yielding hydrocyanic acid or benzoldehyde is present in the pulp or in the skins.

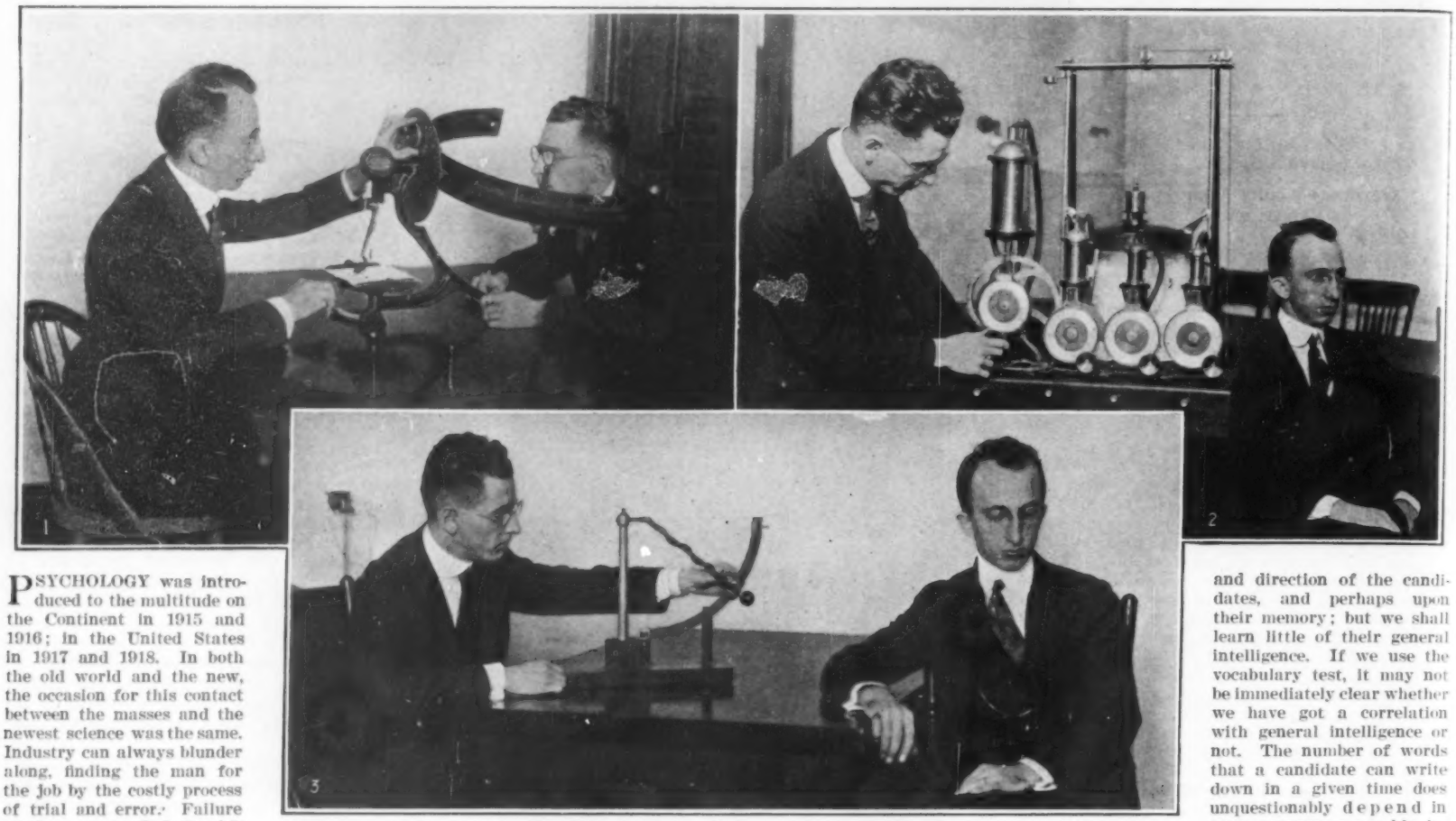
Extracting a concentrated distillate of the peach with ether, a very small quantity of an essential oil was obtained. This was a pale yellow, limpid liquid, which possessed an exceedingly fragrant and intense peach-like odor. When cooled somewhat below the ordinary temperature, it formed a concrete, transparent mass, interspersed with minute, acidular crystals. These crystals evidently consisted of a paraffin hydrocarbon, which, when indirectly isolated, melted at about 52°. The yield of essential oil was 0.00074 per cent of the weight of pulp employed.

In addition to the esters, the peach oil contained a little acetaldehyde and furfural, the latter having doubtless been produced during the process of distillation by the action of organic acids on the sugar contained in the fruit. The presence of cadinene, or a compound giving a similar color reaction, was also indicated.

The essential oil of peach is a very unstable product. When kept for a comparatively short time in a glass tube with a capillary constriction and only occasionally exposed to the air, it became converted into a black, viscid mass, and had then completely lost its original fragrance. This change is in accordance with the character of the constituents of the oil as determined by the present investigation. If the oil, as first obtained, be brought into a glass tube, and heremetically sealed, it appears to be capable of preservation for an indefinite period.

Psychology as a Business

How the Leading Exponents of this Profession Have Organized for Commercial Service and Research



1. Color perimeter, designed to measure the field of vision and the sensitivity of the color zones on the retina. 2. The tone variator which tests the subject's perception of tone differences. 3. Hearing tests, in which the subject is asked to tell from the sound of its impact how far the ball was dropped

Some of the more pictorial of the tests that form part of the psychologist's routine

PSYCHOLOGY was introduced to the multitude on the Continent in 1915 and 1916; in the United States in 1917 and 1918. In both the old world and the new, the occasion for this contact between the masses and the newest science was the same. Industry can always blunder along, finding the man for the job by the costly process of trial and error. Failure of the man to find the job for which he is best suited is the loss of the individual, and none but the individual is going to worry much about it. But under the stern compulsion of war it was necessary to eliminate the period of trial and error, since the loss was no longer a mere money one; the people at large had to interest themselves in finding the best job for the individual.

So in all the larger nations engaged seriously in the war there came into being one or another means of psychological diagnosis of the individual abilities. In Europe it took an actual physical turn; the candidate for a job was put through a number of exercises with finger, eye or ear which it was believed epitomized the physical responses that he would have to make as a machine-gunner, a range-finder, a plane pilot, etc. In this country what we attempted was rather a general examination to indicate approximately the intelligence level of each man, and the degree to which he might be expected successfully to discharge responsible work, to follow instructions, etc.

To some extent in Europe, and much more here, the thing about all this which most impressed the man in the street was a certain aspect of humor. When one has donned khaki, and is being put through a course of training designed solely to make one an efficient killer, one's mind is all on the grim realities of bayonet manipulation and gas-mask technique, the prospects of getting in the fight and coming out of it, and the burning question of how far one will have to hike today. In this frame of mind, one simply cannot be wholly serious about the proposition that one make a cross inside the smaller square and outside the triangle unless a pig has five legs, the suggestion that one transpose the words "Handsome is a top man the sergeant" so that they shall make a sentence, or the demand that one wiggle one's little finger until it refuses to wiggle any more.

If these examples are a trifle overdrawn, they nevertheless indicate the reaction of the average man to the "nut-cracker" questions. It came to many of us as a distinct shock to learn that these tests actually worked. When applied to men who had been under their officers long enough to have records, these tests corresponded closely in what they told about the men to what the officers knew; when applied to fresh recruits they were equally supported by subsequent performances. If the psychologists said that you were practically an idiot, if they said that you were of inferior intelligence, if they said you were just naturally of good intelligence, if they said that you were a brilliant intellect—whatever they said, they were probably right.

At the time when these tests were being given, it was not emphasized that they were to a large degree experimental; but the fact that they were so must have been obvious to anyone giving the subject thought. Questions may of course be put, *ad lib.*; answers graded with mathematical exactness; an accurate statement made of every candidate's standing on the test. All this is easy; but when we have the numerical answer, what does it mean? Have our questions been so framed that the candidate's standing on the test will indicate the things about him that we wish to know? In technical terms, what is the correlation?

A concrete example of just what this means will be illuminating. We may take a large number of men—two million, if so many present themselves or are presented—and we may put them through any test whatever. We may give them 26 minutes in which to write down all the words they can think of beginning with W. We may measure the lengths of their thumbs and their big toes and calculate the ratio between these lengths. We may determine the moisture content of their hair. We may conduct them over a complicated course in town and country and ask them to retrace the route. We may make any measurement, any test, that occurs to us, and record the result.

If we take the ratio between the toe length and the finger length, it is immediately obvious that it will not have any connection with the intelligence of the candidates. It may have a very close connection with some anthropological fact like that of race or environment, but it is quite independent of mental factors—at least, we believe it is. For the anthropologist it has a correlation of some sort; for the psychologist, none. If we adopt the route test suggested above, we shall get an accurate line upon the sense of locality and direction of the candidates, and perhaps upon their memory; but we shall learn little of their general intelligence. If we use the vocabulary test, it may not be immediately clear whether we have got a correlation with general intelligence or not. The number of words that a candidate can write down in a given time does unquestionably depend in some measure upon his intelligence, for it depends upon his vocabulary and his powers of calling up what he knows, and both of these are functions of intelligence. But it also depends upon memory, which is by no means a function of intelligence; and it depends upon concentration, which may or may not be. In the case of candidates of large vocabulary, it might depend on the speed with which these men were able to wag a pencil! Supposing we have put a number of men to this test and counted their lists, what interpretation shall we put on the results?

If we want to know how much a man weighs, we weigh him; if we want to know how tall he is, we measure him; if we want to know how much he can lift, we set him to lifting. Whatever we want to know, if the thing itself is susceptible of direct measurement we measure it directly and we are done. But usually what we want to know about a man is not susceptible of direct measurement—it is his ability in some particular direction, and an ability that is not susceptible of direct numerical indexing. There is nothing left for us to do but to assume that this ability is in direct proportion with some other ability or some physical characteristic that we *can* measure. It is this correspondence between the thing we *can* measure and the thing we are trying to get a line on that the scientist calls a correlation. If the correlation exists our test is bound to be successful and if it doesn't exist our test will be a failure.

How do we know whether it exists or not? In many cases we don't; we are obliged to assume that it does. If we make this assumption, conduct our tests, grade our men according to the results of these tests, put them to work on the job for which we have been testing, and find that the men selected by the test *are* the best workers on that job, the correlation is established. We have guessed or calculated right in casting about for something measurable which would correlate with the ability which we are seeking to determine. And if the results of setting the successful candidates to work do not pan out, we conclude that there was no correlation and we change the tests.

There will often be disagreement as to whether a given test can be expected to correlate with a given ability. Mr. Edison wanted to pick out promising ex-

ecutives, and we all know the curious questions he asked his applicants. Many of us got quite excited about it, and said that there could be no possible correlation between a man's ability to answer these questions and his ability to run a factory. But Mr. Edison said he believed there was such a correlation; and after he had tried it out he said there certainly was one, because the men selected through his tests made excellent foremen.

Even though we be utterly puzzled to account for it, we can object to this conclusion in only two ways. If we be not willing to admit that, for some uncomprehended reason, the correlation is there, either we must claim that the percentage of success scored and accepted by Mr. Edison as sufficient was not so, or else we must insist that he did not try out his test on enough men to get a representative showing.

Both these points are susceptible of easy illustration. Suppose we test for color-blindness by displaying a red lamp, a red cloth and a green cloth, and asking the subjects to state which cloth is the same color as the lamp. If they guess blindly, half of them, in the long run, must guess right. So, in the long run, our test must succeed in materially more than half the cases where it is applied, or it cannot be alleged to have justified itself. In practice, we seek to eliminate the element of chance, to find a test that cannot succeed by accident save in a very few cases. For such a test a success of 50 per cent over a prolonged period would be of some significance. But suppose we have a test which must succeed, by chance, 90 per cent of the time? A very few failures in a thousand applications would be sufficient to cast grave doubt upon its validity.

Again with the matter of getting a representative showing. No matter what the chance seems to be against accidental success of the test, we are not going to claim that its success in one or five or ten cases establishes any presumption in its favor. We must apply it in a very respectable number of cases. We *cannot* apply it in too many; we probably will seldom have opportunity to apply it in enough to establish results of certain value.

The psychologists who were called upon to frame the army intelligence tests were in the same position as Mr. Edison when he asked himself how he could test applicants for employment to find whether they were potential executives. Like Mr. Edison, they were sufficiently clever to get a series of questions that did very well on first trial, but that were susceptible of great improvement. Unlike Mr. Edison, they got enough experience, before they were through with their work, to enable them to make the most categorical statements about what their tests would do, what they would not do, and how to make them do the most that they could be hoped to do.

Psychology had always been handicapped by its inadequate body for data, based upon inadequate experience. The only representative body of humans upon which the psychologist had ever been able to work freely was the body of school children; and they are representative children only, not representative humans. But now the psychologist was put in charge of a laboratory with two million subjects. He was privileged to ask them anything he pleased, and to insist on an answer; they must submit to any test he chose to put. He had unlimited opportunity to check up the results of his prognostications, to locate correspondence and discrepancy between test results and subsequent performance. Of course psychology came out of all this with an accumulated fund of experience and of positive data that could not have been acquired in any other way. For even if, after decades or centuries, such tests as these had finally been applied to as many subjects as the psychologists found in the army, there could never have been the same assurance that these subjects were a true cross-section of the human race.

Another thing that all this did for the psychologist was to advertise him. Several million men were subjected to the tests. Every literate person in the United States read about them and had it impressed upon him that they were actually working. Every individual who had reason to suspect that he was in the wrong job, or to wonder what line he would find most suited to his personal equation, must have had it brought to his attention that here was a way of finding out that was worth trying. Every employer of men who had encountered (as what employer has not?) the extremely difficult problem of distributing his jobs among his people to the best advantage, however scornful he may have been when the psychological tests first came to his attention, must eventually have wondered whether, after all, this queer catechism could not be made to work in his plant. And all that meant business for the psychologist, after the war was over.

The man on the right gives a signal, the subject at the left records it; and an electrical circuit indicates the time elapsed. Surprising differences in the "reaction" intervals of different individuals, or of the same individual working through eyes and through ears, are noted

Testing the speed with which the candidate responds to stimulus

Now if anybody knows the advantageous way to do business, the advantageous way to get it, the advantage to which it may be put after it is obtained, that person ought by good rights to be the psychologist. And today there is an office in the Grand Central Terminal Building in New York which is abundant testimony, in the very name on its door, that the psychologist has known how to do these things and has done them.

The concern that is quartered in this office is a sort of selling organization for —well, we cannot resist the temptation to call it the Psychology Trust. The leading psychologists of America have got together. Most of them, quartered as they are at the prominent universities, must have their laboratory facilities close at hand; so it has been rightly decided that there is no particular profit to be got, either scientifically or materially, by concentrating actual psychological work done in one big psychological factory. All work done by the members of this organization, with trifling exceptions, will, as before, be done in their own laboratories or in the plants of their clients.

What the organization will do is make the contact between the producing psychologist of the laboratory and the mar-

(Continued on page 142)

Fighting a Mud Run

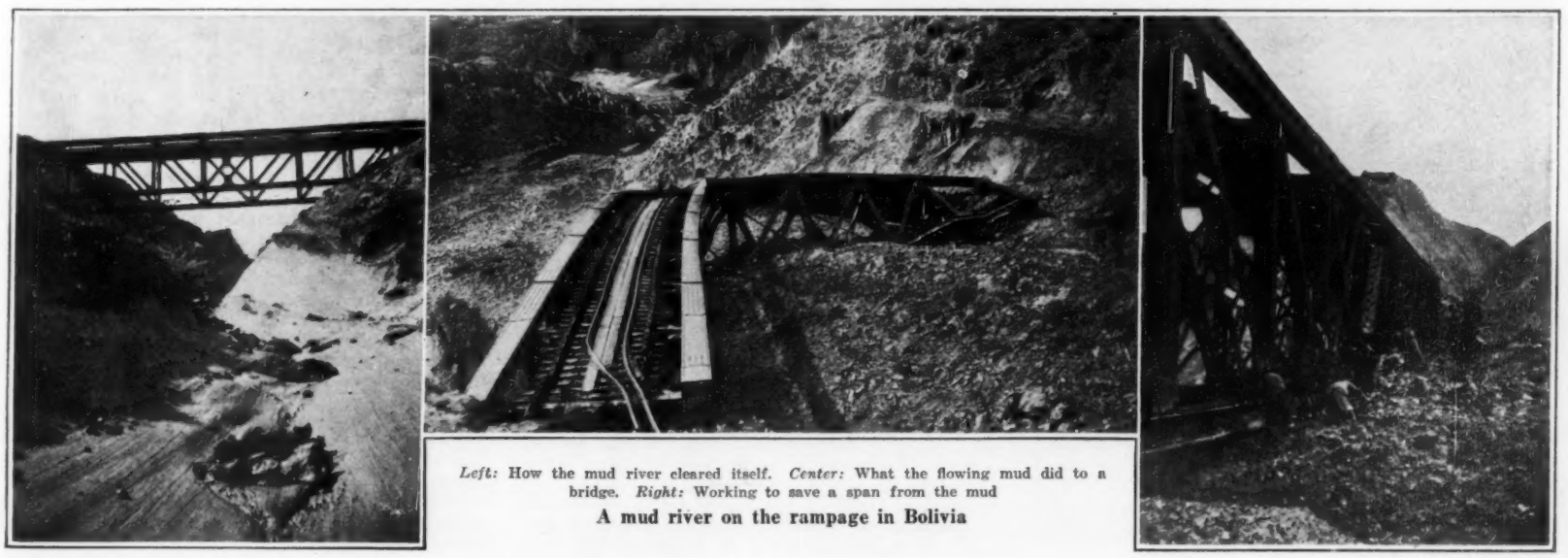
By P. J. Risdon, F. R. S. A.

IT is not generally known, except to scientists and engineers, that in parts of the world, especially in mountainous districts, there are big ranges of hills, some with quite precipitous sides, that consist almost entirely of mud—the products of disintegration of mountain ranges by nature's forces.

So long as these mud hills are dry and undisturbed they will remain firm and will stand with almost vertical slopes, but with heavy rains or when otherwise disturbed, as for instance by earthquake shocks, vast quantities—much of it still quite dry—become detached and slide down somewhat after the manner of glaciers.

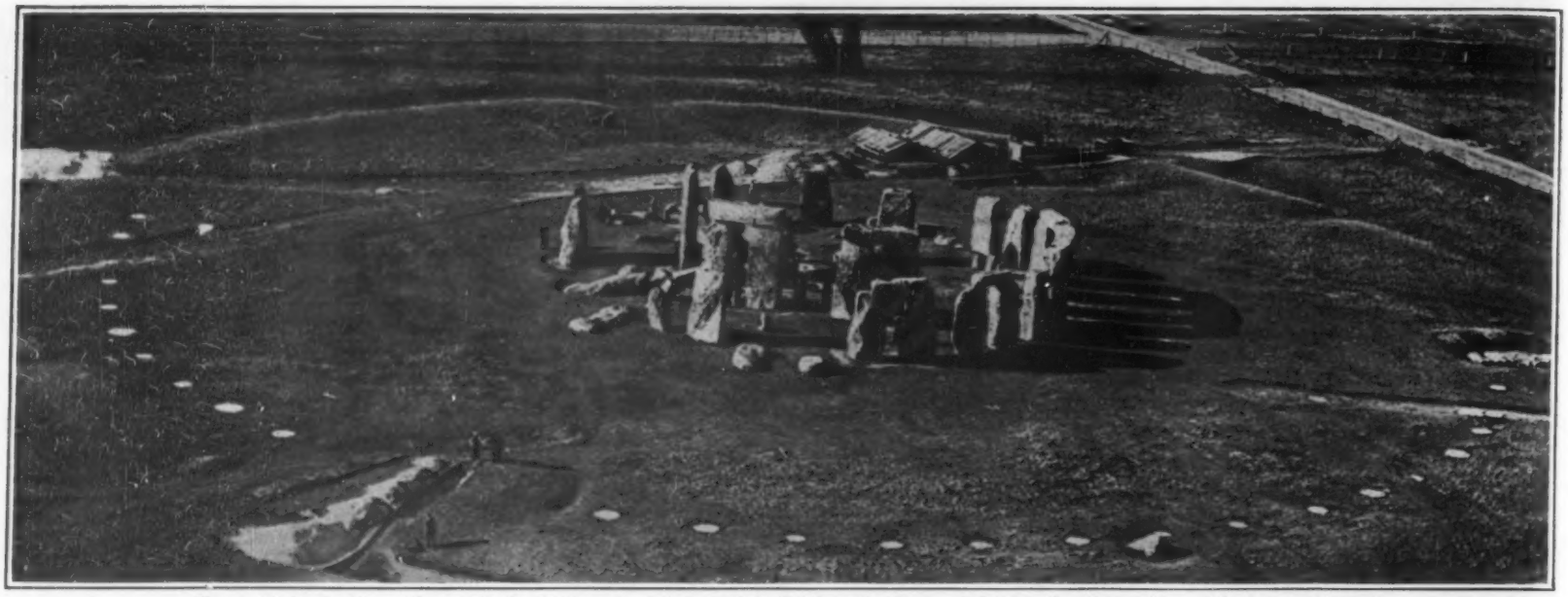
One curious effect is that the location of a railway section may become appreciably altered without necessarily resulting in interruption to traffic. One of the most troublesome features is the choking up of valleys and endangering the safety of bridges, and our photographs show what actually happened to a bridge on the Antofagasta Railway.

An urgent message was received that an avalanche of mud was slowly approaching and filling the valley spanned by a steel-girder bridge 120 feet long carrying the railroad track. Breakdown gangs were hurriedly dispatched and made desperate efforts to disperse the oncoming mass. Almost as well might they have attempted to divert a glacier. Slowly but surely the valley was filled to the level of the bottom booms of the bridge. Still higher rose the mud until the sheer weight and pressure of this soft material tore the two hundred tons of steel from its masonry bearings and swept it hundreds of yards down to the plains below.



Left: How the mud river cleared itself. *Center:* What the flowing mud did to a bridge. *Right:* Working to save a span from the mud

A mud river on the rampage in Bolivia



The semicircle of white patches marks the location of recent excavations that have thrown new light upon the origin and use of the famous monument

Stonehenge as seen from an airplane

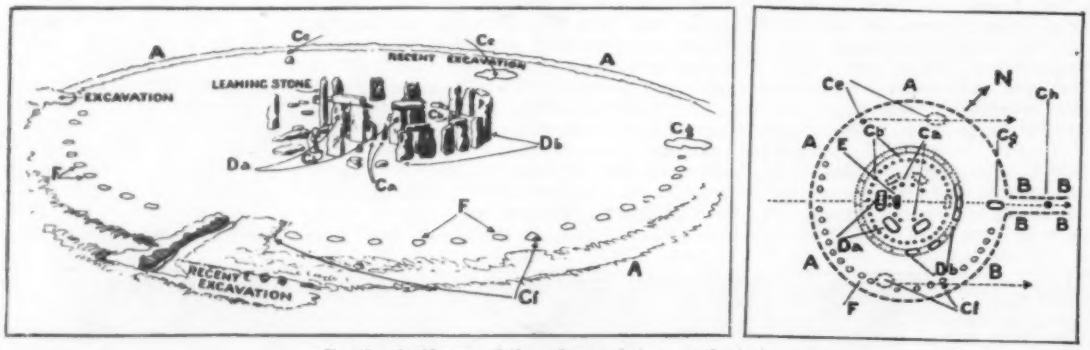
Stonehenge—The Enigma of Salisbury Plain

Two New Theories Based on Recent Discoveries During Restoration

TWO circles of stones, one within the other. The whole surrounded by a double wall and ditch 1100 feet in circumference. The outer circle 105 feet in diameter, consisting of 60 stones, half upright and half horizontal, the upright ones 16 feet high and 6 or 7 feet thick. About 9 feet within, the inner circle of blue stones, originally 40 in number. Within this again a double row of stones in horseshoe form. Such is Stonehenge. What is its history? Why was it built, when, by whom? These are questions which no one has ever answered satisfactorily.

Sometimes regarded as of Druidical origin, it is plainly much older—though the Druids doubtless used it. Other theories involve a race of sun-worshippers in Britain at some such date as 1800 B. C. Then it has been suggested that Stonehenge is a Buddhist temple; a fortress; a meaningless pile which the Romans forced the Britons to build to keep them quiet. In any event, since some of the stones weigh 30 or 40 tons, the question "How?" is as outstanding as the question "Why?"

In connection with the restoration described in our issue of September 25, 1920, new data have come up of surpassing interest. For our account of this we are indebted to the *Illustrated London News*, as well as for the remarkable view of the restoration by Mr. W. B. Robinson, and the ground plan by Mr. A. E. Lee, which are presented herewith.



For the significance of the reference letters see the text

Key to the photograph above, and ground plan of the ruins

On the basis of flints, pottery, beads and other ornaments unearthed during the restoration, together with critical examination of the stones, which are partly of local origin and partly brought in from some other locality, Mr. J. E. Gurdon has developed a theory that Stonehenge was a sort of prehistoric Westminster Abbey, Royal Exchange and Racecourse rolled into one. He points out that the trilithons—two uprights carrying lintels across their apices—are all of sarsen, a rock commonly found right there on Salisbury Plain; but that the smaller, isolated uprights are "foreign stones," since nothing resembling them has ever been found in Wiltshire. Clearly the presence of these requires explanation, and explanations without number have been advanced. It has been suggested that these stones were deposited by glacial action; but the Wiltshire gravel carries no glacial pebbles of similar material, which would inevitably be found if this suggestion were correct.

Mr. Gurdon points out that the builders of the trilithons used local stones, and that it is hard to imagine any motive for their roaming far afield for other stones, for the less important isolated uprights. So he assumes that these foreign stones belong to an earlier period, and this is made more plausible by the careful trimming of the trilithons, which is not to be noted in the foreign blocks. In short, the latter form either a part or the whole of a much older temple.

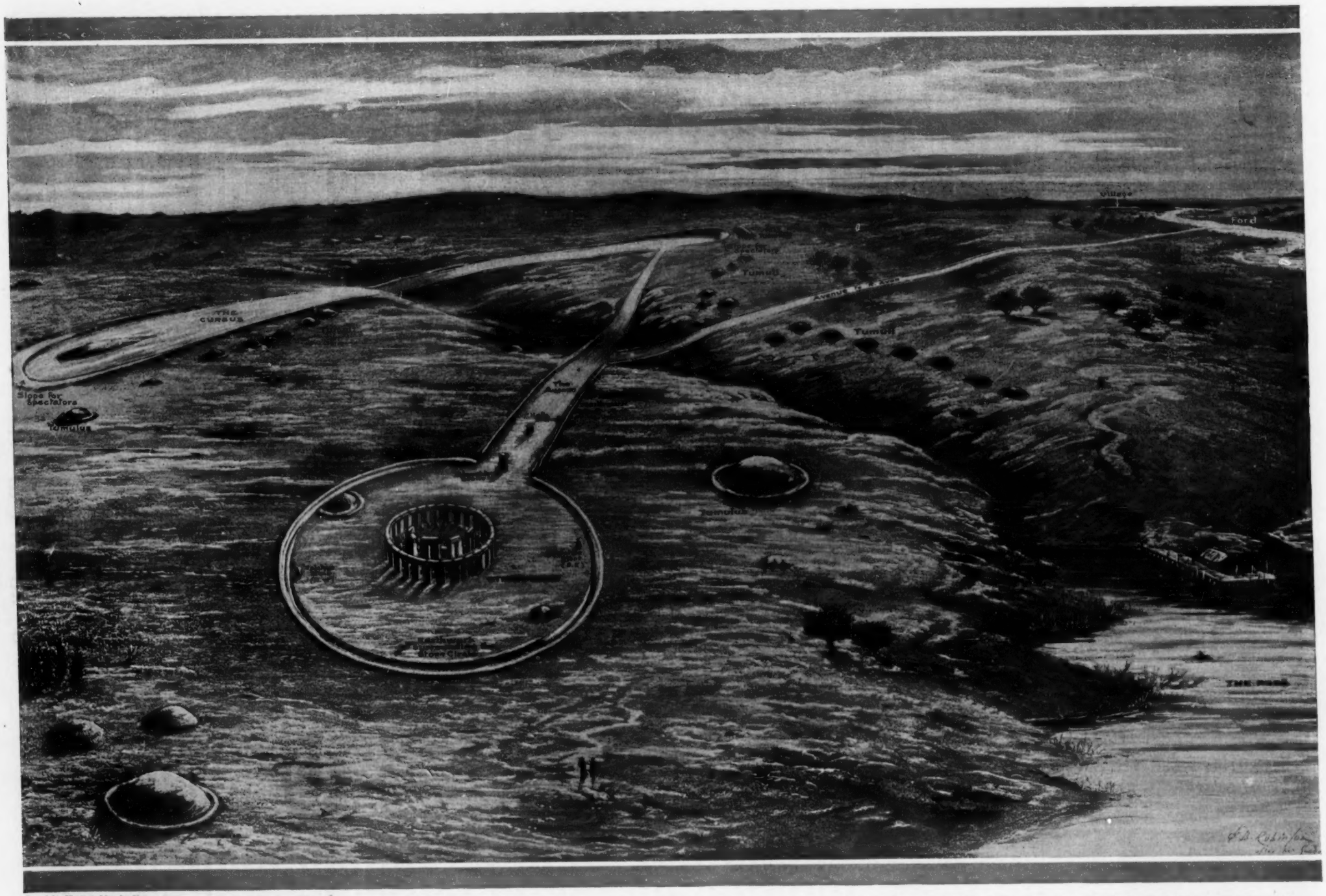
After discussing the uncertainties of primitive barter, and pointing out that the one place where the weaker barterer might feel safe from violence was in a sacred inclosure, Mr. Gurdon develops his argument that Stonehenge was such an inclosure devoted largely to purposes of trade. Its double antiquity seems to him good support for this idea; "since the foreign stones indicate sanctity previous to the coming of the trilithon builders," he says, "it is not extravagant to assume that the only meeting-ground safe alike to the older residents and the immigrants should be the mutually-sacred area. Intercourse would therefore naturally gravitate to Stonehenge, bringing with it a revival of trade with less local tribes already accustomed to the security of the neighborhood.

This sounds plausible enough, and Mr. Gurdon backs it up by pointing out that within a narrow circle inclosing the building there lie countless fragments of flints, bone tools, broken domestic pottery, beads and bronze ornaments, for the presence of which no advocate of a strictly religious Stonehenge has ever accounted.

Mr. Lee, who has been responsible for the ground plan which we show, is not in sympathy with Mr. Gurdon's ideas. He is "inclined to the view that the existing foreign stones are *in situ*, and that other stones have been removed from the depressions at a later date and possibly destroyed. As to the avenue leading from the Temple to the Cursus, there is strong evidence of a religious purpose. It is fairly well oriented, not only with the axis of the temple, but also with Sidbury Hill eight miles away." The axis of the older temple does not coincide with that of the new. Mr. Gurdon's suggestion that we take the name "Cursus" seriously, and assume that the prehistoric users of Stonehenge actually did combine sports with their business and religion, Mr. Lee likewise finds unacceptable.

Mr. Lee's notes, explaining the reference letters in his ground plans, are as follows: A is the Temenos mound and ditch, much degraded. B is the Avenue, formerly traceable for some two miles. It is approximately parallel with the azimuth of June sunrise for 1700 B. C. The stones of the older horseshoe are marked Ca, and Cb represents the earlier circle. Ce and Cf are outlying stones and mound systems at the northwest and southeast. Cg is a stone fallen on its axis. Ch is the Friar's Heel, standing. Da are the five trilithons of the newer horseshoe. Two are still standing, and what has been called the "leaning stone" is one of the uprights of a third. The tallest of the circle stones, it has been restored to upright position, and a well-marked tenon on its top noted, where it locked with the capping stone. Db is the newer circle of upright stones, with originally continuous capping stones. E is the "slaughter stone" of different material from any of the others. Probably it was originally prone. F are bare places which became apparent during the drought of last year, and which appear to mark the spots from which stones have from time to time been removed for ordinary building purposes in the neighborhood. It is indeed a pity that persons of former generations should have removed some of the stones which are today priceless, merely because they required building materials.

Among the interesting legends surrounding Stonehenge is one which attributes its construction to His Satanic Majesty. We are informed that the Devil brought the "foreign stones" by air from Ireland; and that when adjusting his burden near Burferd one of them slipped and fell into the Avon. Such a stone actually has been located in the river bed, and doubtless this is what gave rise to the legend, which, with gentle British humor, Mr. Gurdon remarks "requires further confirmation."



In the center we have the two circles of stones, the inner one of isolated "trilithons" and the outer of continuously capped uprights. Certain of these stones are of local origin, and others were brought in from some point a very considerable distance away. According to the latest theory, this is taken to indicate two separate epochs of construction, the older, "foreign" stones having been salvaged from the first temple for use in the second one. The "Avenue" which leads from the outer encircling earthwork ring to the "Cursus" and to the Avon River is largely destroyed, but was formerly traceable for a sufficient distance to establish its original location. One of the most heated points of controversy revolves about the precise original use of the "Cursus."

STONEHENGE, RESTORED AS THE RECENT INVESTIGATIONS IN CONNECTION WITH ITS CLEANING UP MAKE IT APPEAR TO HAVE BEEN ORIGINALLY LAID OUT

Do Tables Tip?

Some Critical Comment on Crawford's Investigations and Carrington's Summary Thereof

By James Black

IN an article by Dr. Hereward Carrington, entitled "When Tables Tip," in the June issue of the SCIENTIFIC AMERICAN, reference is made to the investigations of the late Dr. W. J. Crawford, and what purports to be a summary of these investigations is used to prove that the levitation of tables is established as a genuine psychic phenomenon. For this to be so it would be necessary for Dr. Crawford's investigations to prove something, and for the summary thereof to be in accordance with fact. It appears in order, therefore, to examine the investigations critically, and ascertain what claim they have to be considered scientific, and the results to be considered facts. It is equally in order to compare the summary thereof with the investigations. In this examination it is necessary at all times to remember that the function of science is the classification of facts, and the recognition of their sequence and their relative significance.

As there is frequently considerable mysticism and, at times, dubious circumstances in connection with the establishment of proof of psychic phenomena, it will be convenient to examine the conditions under which Dr. Crawford conducted his investigations. These are related in considerable detail in his book "The Reality of Psychic Phenomena"; and from this the following information is obtained:

The investigations were in the form of experiments regarding the levitation of tables, and were conducted in a "spirit circle." The "circle" providing the phenomena was a family one of seven or eight members. All were mediums, and Miss Kathleen Goligher was the principal medium. The place was the attic of the house in which the medium lived. There is absolutely no mention of any precaution being taken to prevent or detect fraud. The only assurance that fraud was not committed is Dr. Crawford's assertion that the family was of high religious and moral character, and that the members of the circle were his personal friends. This is opinion—it is not evidence. The light conditions of the seance-room made fraud quite possible. A feeble light from a flat-flame gas burner, inclosed in a red-glass lantern, left the room so dark that the regions under the table and in front of the medium had no visibility. It was so dark that the readings of instruments under the table were made by touch. A feeble flashlight, with the lens covered by several thicknesses of red tissue paper, was necessary to take the readings on the steelyard of the weighing machine upon which the medium and her chair were placed. Dr. Crawford states that a fairly strong light could be flashed on the top of the table, but a similar light—red, of course—flashed under the table or in the direction of the medium always caused a cessation of phenomena.

Dr. Crawford's account of what happened at these seances, or investigations, is not as clear as is expected from a scientist—in fact his statements are very contradictory. A few of the contradictions that offer difficulties to the critical examiner are here isolated.

"No dark seances are held," Dr. Crawford assures his reader. Yet under Experiment 84 he says "The gaslight having been turned off . . . we were left in total darkness"; and under Experiment 85 we read "The room being pitch dark at this time—the only occasion in all my experiments." I need not point out the double contradiction here.

At one point in Crawford's book we are told: "The medium is the least enthusiastic member of the circle. She is the only one who cares little about the phenomena. I think she sits more as an obligation to the others than for any innate satisfaction to herself. Whether phenomena are obtained at the seances or not does not affect her in the least." And against this we learn, in another passage, that the medium "was always keenly interested in the experiments, and has told me she enjoys such sittings much more than ordinary development seances. It was amusing to watch how interested she was when, say, an electric bell was rung. . . . Many times I have observed the keenness with which she followed what went on." I am aware that it may be claimed that her indifference applied to ordinary seances, her interest to those of an investigational character. I do not think that this covers the discrepancy between these two passages.

In all experiments, it is to be remembered, the table was in front of the medium. "The observer . . . may be within the circle, and he may move anywhere inside it so long as he does not get immediately in front of the medium." Yet in another place Crawford insists "I have continually worked . . . between the levitated table and the medium."

"Now the only way such movements could be given normally to the table," he remarks, "is by the feet of the medium. . . . If the medium leans back in her chair and endeavors to levitate the table she may do so . . . in a jerky kind of fashion; but the real levitation is of quite a different character . . ." Yet Experiments 4, 16, 41, 46 and 61, among others, detail a jerky levitation as part of the phenomena.

"During levitation raps and blows are very seldom given, and then only of the feeblest type." But in Experiment 85 "the room being pitch dark . . . a small earthquake seemed to be playing in the room. The table . . . turned upside down and levitated in that fashion. The blows on the floor were terrific."

The critical student of Dr. Crawford's work may believe either of these sets of contradictory statements—he certainly cannot believe both. But which one is true? Thus far we have no indication of scientific method either in the conditions of Dr. Crawford's investigations, or in his comments and conclusions thereon.

We will now consider a few of the experiments, both for indications of scientific value and for their agreement with Dr. Carrington's brief summary thereof. Dr. Carrington states that in experiments "The medium, chair and all, was placed upon . . . a weighing machine. Her weight noted, . . . the table was 'levitated.' During levitation it was found that *the medium increased in weight by . . . the precise weight of the table.*" This statement is contrary to fact.

In six experiments recorded by Dr. Crawford there is not one in which the weight added to the medium was the precise weight of the table. In two cases the table weighed 166 ounces; in one of these cases the additional weight of the medium during levitation was 156 ounces and in the other 168 ounces. When the table weighed 168 ounces the medium gained 162 ounces; when the table weighed 96 ounces she gained 90 ounces; when the table weighed 100 ounces she gained 94 ounces; and when the table weighed 44 ounces she picked up 46 ounces. The percentages of the medium's increase to the net weight of the table are, respectively, 63.9; 101.2; 96.4; 93.7; 94.0; 104.5.

The complexities of this showing will be realized if an attempt be made to establish a definite ratio between the weight actually added to the medium and the weight of the table. The lightest table gives a greater percentage of excess weight than the heaviest one, while the heavy table gives a greater percentage of short weight than one of the light ones. Dr. Crawford states that the "apparatus used in these experiments was quite suitable for obtaining results—not so accurate, perhaps, but nevertheless of much value." Well, then, of what value? And just what is proved?

Dr. Crawford made very conflicting statements, already noticed, about the space between the medium and the table, so we will see whether his experiments prove that no physical connection could exist between the medium and the table. Experiment 59: "A delicate electric contact-maker was moved here and there in the air in front of the medium, while the table was jerking about on the floor. At a spot about two feet above the floor contact was made, the bell rang and the table stopped moving." Experiment 60: "While the table was levitating the contact-maker was moved in front of the medium. At practically the same spot the bell rang again and the table instantly dropped. The 'spirit' operators would not allow me to proceed with the experiment." In plain English—the space between the medium and the table must not be investigated. A complete demonstration of no physical connection was not made, and a very different conclusion is permissible.

Dr. Carrington's version of the spring balance experiments is incorrect in every detail. To test the pressure under the legs of the levitating table Dr. Crawford used his hand—not a spring balance. In the only experiment to which he placed a spring balance under a table while it was levitating the table "fluttered like a wounded bird and dropped gently to the ground," and no weight was recorded. He concludes that the space displaced by the balance—8½ inches high; top, 8 inches by 6 inches—is a factor in the levitation. This conclusion is very conveniently lost sight of in subsequent experiments with much larger balances. Again the statement that "when the balance is placed under the table the reaction is supported by the balance, and the weight of the table thus registered," is a statement of just what *did not happen.* In all the experiments made with a spring balance under the table there is not one in which the weight of the table is recorded.

We will quote Dr. Crawford to see what really happened "Experiment 50: To find the exact value of the vertical downward force on the pan of the balance while the seance-table, weight 10¾ pounds, was steadily levitated above it. Result: the vertical downward force on pan is 30 pounds, and this value is correct to 1½ pounds either way, and probably correct to one-half pound either way. Conclusion: weight of table, 10⅜ pounds; vertical downward force on compression balance during steady levitation, 30 pounds; horizontal pushing force on balance, 5¼ pounds."

The horizontal force came from the direction of the medium and was registered with a piece of chalk! The vertical force was registered by touch! The totality of forces registered is, without allowing for the admitted variations, about 3.35 times the weight of the table. In the case of a table weighing 2 pounds 14 ounces the average of four experiments gave a registration of 18¾ pounds or 6.8 times the weight of the table, with no record of the horizontal force. In addition to the forces mentioned, Dr. Crawford states that some of the weight of the table is on the medium, even though from 3.35 to 6.8 times the weight is already accounted for! This is curious and interesting—but affords proof of absolutely nothing.

These experiments, conducted in dubious circumstances, in a slipshod manner, are, at best, rough-and-ready values, by no means exact, of a force that is not necessarily psychic. The results have no relative significance, nor any confirmation, even by Dr. Crawford himself. They prove nothing, except that Dr. Crawford had not that nice regard for accuracy of detail in research that is essential to the scientist.

Dr. Carrington presents a version of the facts so glaringly inaccurate that many who rely on his statements may be led to false conclusions. One of the failings of many psychic researchers is their inability to understand what constitutes evidence, and proof; another is their susceptibility to take anything that they care to dignify by the name of "scientific evidence" and twist, push, pull and distort it until it is in such shape as suits their needs. The sooner this reprehensible practice is stopped the better for their cause. Let it stand on truth—or let it fall.

CRAWFORD'S work and Crawford's book have been highly commended and bitterly assailed. No good purpose can be served, we believe, by dissembling the fact that Crawford killed himself. No good evidence exists that, as is sometimes charged, he did this on discovering that his medium was a fraud and had tricked him. The fact seems to be that he found himself suffering from a progressive and incurable mental disorder, which he was not willing to endure beyond its initial stages.

Reference to this is on the editor's initiative, and not at all on Mr. Black's. Crawford believed, and explicitly stated, that the onset of his insanity was later than the Goligher experiments. Even if he were wrong in this, his psychic investigations could still be judged on their merits; work of this character will always stand or fall on its intrinsic merits, regardless of the investigator's personality. Mr. Black has analyzed Crawford's work, and Dr. Carrington's summary thereof in our June issue; and he finds neither worthy of serious attention. We are sure that, whether our readers agree with him or not, what he says will be of intense interest.—THE EDITOR.

Inventions New and Interesting

A Department Devoted to Pioneer Work in the Various Arts and to Patent News

The Non-Capsizing Tumbler-Heater

MANY of us have had the disagreeable experience of overturning the vessel in which we were preparing to use an electrical heater of the ordinary immersion type. We may therefore be in a good position to appreciate the advantages of the tumbler-heater illustrated herewith, which clamps on to the edge of the glass in such a way as to lend a maximum of convenience to its use. When one wishes only to heat the fluid contents of a single glass, such a device as this one is extremely handy.

Rubber Compound for Battery Boxes

RUBBER compound battery boxes to replace those of wood containing hard rubber jars are now being manufactured by an Indianapolis concern. Many attempts have been made to make boxes of hard rubber but it has been found that these boxes are too brittle and do not stand up under the freezing test. The new compound is made from a secret formula and it is claimed both these points have been overcome. In addition, it is claimed that these boxes overcome the difficulties encountered with pin-holes, blow-holes, and other forms of leakage which are common with hard rubber products. In order to overcome these defects, the new box is made by building the battery box up by hand, thereby laminating each piece of rubber and overlapping each piece at the corners. The boxes are then cured under very high pressure. The compound of which the box is made, it is claimed, has the ability to resist absorption of water or acid. The jars and box are combined in one unit, which gives it considerable structural strength besides that imparted by the physical qualities of the material. It is also resistant to heat to a very satisfactory degree.

The Adjustable Tooth-Brush

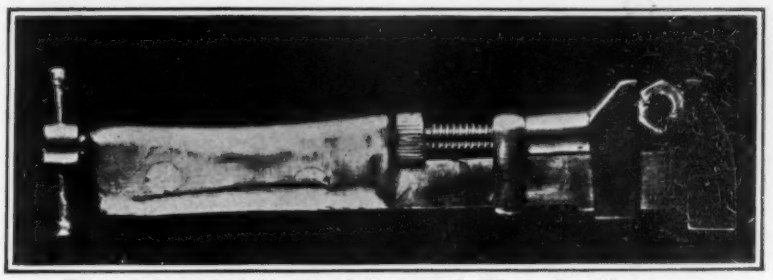
IN these days when we are all urged to brush our teeth with the most meticulous care, it may be interesting to learn that there is available an adjustable tooth-brush to aid us in the task. The adjustability resides in the cross-head which in our picture is shown carrying the bristles. This rotates at the user's pleasure to make any angle with the handle, enabling one to explore with the cleansing agent the most inaccessible corners of the most tricky mouth. The general idea of arranging the brush across instead of along the handle is in itself, apparently, a bit of an improvement; and the adjustability should remove the last temptation to slight the important business of combatting the acid-mouth and other dire things with which the modern dentifrice advertisements threaten us.

The head of this tooth-brush can be set at any desired angle with the handle

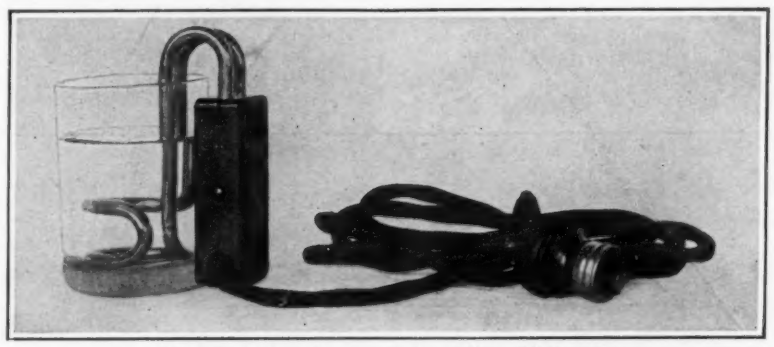
A Wrench Built Like a Vise

THE monkey wrench is a great institution; but the extent to which special wrenches of the goose-neck, socket, and even the rigid, single-size type are used to its exclusion is sufficient evidence that it leaves something to be desired. Our own experience with it suggests that the principal reason why it is not in more general use is that, when screwed tight enough to give a purchase without slipping on a really recalcitrant nut, it cannot be loosened by hand, but has to be started with a pliers. And naturally no mechanic can think of picking up and using the pliers every time he shifts his wrench.

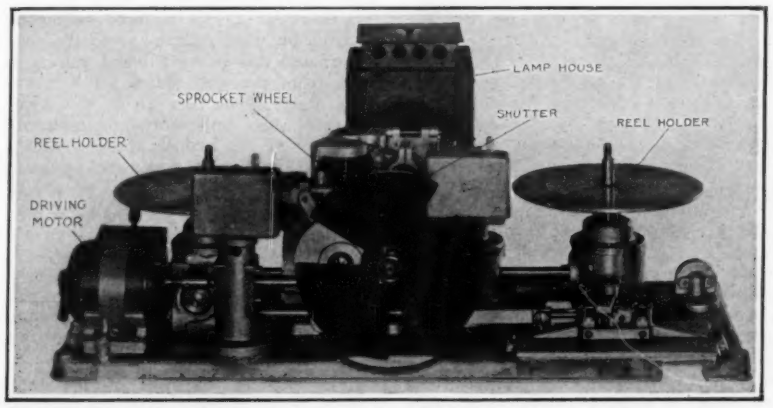
Mr. Eugene Chennette, of Omaha, has recently patented a modification of the monkey wrench which seems so very effective and so very logical that one is moved to wonder why nobody ever thought of it at all. He calls his implement the vise-wrench, and a glance at our photograph will show why. Explanation of the working of this elegant little tool would be superfluous; but we would pause long enough to point out that little additional complexity of manufacture is introduced by the vise feature, since the shaft has in any event to go part way into the handle, and may with little more expense be carried clear through to the butt and have a vise-handle attached. Incidentally, the automobilist who carries his tools loose under his rear seat will probably find the vise-wrench in pieces that have to be carefully picked out and put together much less frequently than he does in the case of the monkey wrench.



The vise feature of this wrench insures a bulldog grip with an easy disengagement



A handy device for small quantities of hot water



The store-window film projector, which reflects the picture to the eye from a mirror and thus avoids the usual dimming effect of daylight projection

Automatic Daylight Movies for the Store Window

WINDOW displays must be unusually compelling to be effective. Clever color schemes or costly fittings do not always catch and hold the eye of the passerby. Where so many up-to-date retail merchants are employing artists and expert decorators to create window settings and arrangements for them, it is a difficult thing always to have window displays that will outdo those of competitors. It is an even greater problem to get window displays so effective that they seize the casual interest of the passing throng and lead the prospects into the store all prepared to buy.

The recent perfection of a motion-picture machine designed for daylight operation in store windows, showing human-interest films with an advertising message, introduces this very type of advertising medium, one of great importance to every advertiser of any consequence. It combines automatic control, successive operation and rewinding over and over, fireproof construction and perfect daylight-picture reproduction.

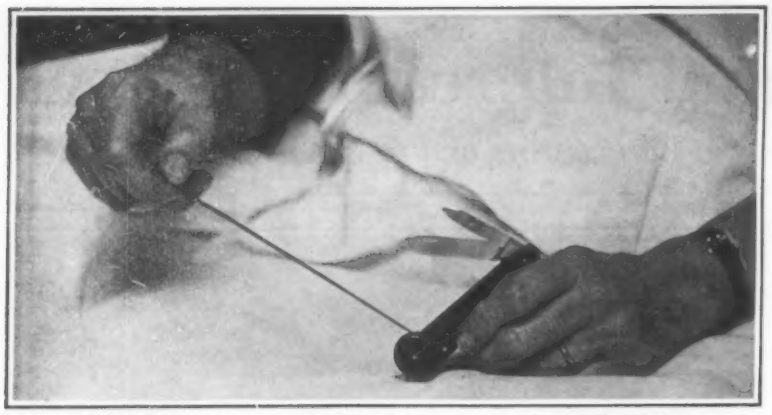
This unusual device gives the spectator the sensation of being in a motion-picture theater. He can see no operator; there is none—a time clock controls the motor driving it—running a 500-foot film in about seven minutes, then rewinding, and so on, hour after hour, until the clock shuts off the motor at the time set.

The operating mechanism comprises an aluminum frame casting, on which are mounted the driving motor, controlling resistance, special safety and reversing switches, the machine head and two horizontal reels carrying the films, together with supplementary appliances. This compact apparatus is protected by a metal-covered asbestos casing. It is placed beneath a shadow box, made to resemble a miniature theater stage, in the back of which the motion pictures appear.

The pictures are clear and life-like. The dimming of images thrown directly on the screen in bright daylight—always up to now an obstacle to daylight motion pictures—is done away with entirely. The images, instead, are reflected in the direction of the spectators' eyes by means of a mirror, tilted at an angle of 45 degrees, in the back of the miniature theater cabinet. These reflected pictures do not lose their brilliance, even in the strongest sunlight.

The film unreels and rewinds horizontally instead of vertically. A frame carrying a special mirror, mounted in front of and above the projecting mechanism, first reflects the picture on to the horizontal ground-glass screen in the bottom of the shadow box, from which it is again reflected toward the spectators by the large tilted mirror in the back of the theater cabinet.

The projector is designed to carry 500 feet of standard film of a non-inflammable material. Special perforations, licensed by the National Board of Fire Underwriters, prevent the use of the ordinary inflammable film in the machine. The fireproof booth usually required



A steel tape-line is part of the latest combination pocket knife

wherever films are shown is, therefore, unnecessary. There can be no danger from fire to the merchant who gives the machine space in his window.

Mounted in a store window, the entire equipment occupies only a comparatively small space. In every case merchants have been only too glad to give it a place, because it has never failed to boost sales very materially no matter how little the picture shown has had to do with the goods they were selling.

Broadway throngs and Broad Street crowds in Newark, N. J., have shown keen interest in recent installations of the machine in the windows of a number of prominent stores and banks. The crowds gathered before it almost as by magic — anywhere from 25 to 100 people—and stood absorbed in the picture until it started to rewind. They disappeared then just as quickly, to be replaced by another group equally interested. Out of this endless succession of prospects there is a steady detaching of persons who have seen some article they want in the window and who enter the store to purchase it right away. From the moment the advertising machine starts until it is shut off late at night, buying is stimulated in this positive fashion.

The riveter's hand-forge that supplies its own draft and clears its own coke gas

A Better Hand-Forge

WHEN he got a pain in his shoulder from operating the fan blower of his hand-forge, Lawrence Crawford, head riveter in a Pennsylvania shipyard, got his inventive mind busy on the problem of a forge that would supply its own draft. An early experiment with compressed air indicated that the air was all pressure and no body; and the inventor proceeded to get away from this by designing a diffusing nozzle. At the same time he found it possible to rig the outfit up so that it disposed of the troublesome coke gas.

The fire-pot consists of sheet iron lined with fire-brick. Underneath the pot is a cast-iron air duct through which the current of air flows. The compressed air flows through a constricted throat or nozzle, and is subsequently discharged through a conical aperture, thence through a cone with a number of small holes in it. The air is subject to the control of the cone. This forms a body of air which flows through an air duct downward into a chamber, then upward into a tuyere iron through a number of staggered holes that are on an angle. This prevents the flame from coming up in the center of the fire-pot. The self-feeder is fastened to the forge with iron bars which hold it in position up off the level of the fire.

This feeder, after it is filled with coke, works automatically. Therefore the coke that is at the bottom of the feeder is gradually ignited, and the gas that escapes through the feeder is consumed by the flame that circles outside the feeder at the top. This makes it very pleasant for the holder-on to work between decks, or in small compartments of any description.

A Pocket Knife with a Tape Line

TO the numerous handy accessories that are provided with the pocket knife may now be added a steel tape, wound in one end of the handle of a recent model, after the fashion of the familiar tape roll. As with its big brother, this little tape is provided with a clip at one side which holds it out, and with a spring that draws it back on to its roll when the clip is released. On one side of the tape is found a scale in inches and on the other one in metric units. For many purposes this clever little outfit will be keenly appreciated by its users.

A Headlight for the Vacuum Cleaner

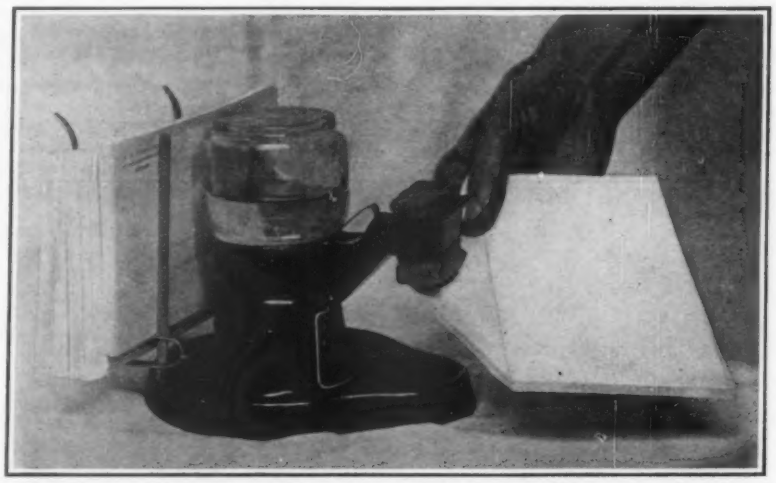
THE photograph which we present herewith shows how one clever housewife made it possible to use the vacuum cleaner in the dark corners with the same assurance that she formerly felt in attacking these spots with the trusty broom. Not only does this make the vacuum apparatus available in dark corners, under stairways, etc., but it greatly reduces the likelihood of picking up pins and other hard articles that dam the cleaner.

Manufacturers, please copy, suggests our photographer; and we are not sure that he is not right.

Using the vacuum cleaner in the dark corners

An Artificial Tongue for the Stamp-Licker

FOR the payroll clerk who must count paper money, the mailing clerk who has numerous stamps to stick and envelops to seal, or any one else whose work requires the use of an artificial "licker" which must always be moist enough but not too moist, a new device operating in a new way is on the market. The moistening pad is suspended, with water above it and below it. The pad is automatically watered by means of a cotton wick running from the well below, and this is replenished automatically from the well above. The water from above seeps through to the lower reservoir just sufficiently to maintain the wick at the proper state of moistness, so that there is never any tendency to flood the pad. When used as an envelop sealer, the device is equipped with a removable rack, as pictured, in which the sealed envelops are accumulated. It will be noted that in its *modus operandi* the moistening pad is really a much closer approach to the human tongue than is usual with these moistening devices.



This stamp- and envelop-moistener supplies just the right amount of water

The Suction-Cup Tire Chain

THE average tire chain is a mighty useful institution, but, after all, it grips the road with little more than an ordinary surface friction. There seems plenty of scope for the effort to endow it with a more positive grip, and a Chicago inventor, Mrs. Ida V. Benoit, has attempted to do this. Instead of leaving the business of consolidating the wheel and the road to the links of the chain themselves, her model employs the links merely as carriers for a series of metal cups, concave on the side presented to the road. We get then an action similar to that of the vacuum-cup tire, but more pronounced because of the manner in which the chain must necessarily bite the road. As is now the case with the better-made chains of the more conventional types, the cross-links carrying the cups may be replaced as they break; and patent situations permitting, they may even be substituted individually or collectively for cross-links of the more ordinary styles.

A tire chain designed to take firmer hold of the road

Using the Engine as a Brake

THE natural impulse, in using the engine as a brake, is to open the throttle to get more braking power. This is wrong. At given engine speed, just so much air must be pumped; and the engine must work harder to draw this amount in through a closed than through an open throttle.

Whatever the size of the jar, this handy tool will loosen its balky top

A Wrench for All Jars

HERE is a little kitchen tool that has much to commend it for a member of the household tool kit. It is used for opening screw-top and vacuum-capped bottles, which are always a source of annoyance to open. It will fit around a cap of one inch diameter or five, as the case may be. It works on the principle of a slip-joint plier.

A Mechanical Barber for the Hedges

THIS mechanical barber for your hedge mows it down in one-tenth the time a gardener requires to accomplish the same task with a sickle. Our illustration shows the method used for trimming a high hedge.

We are told that to secure a thick hedge it should be trimmed at least once in three weeks, when new shoots will spring out immediately back of the fresh cut. This machine can be used by one man or by two, and will make a side cut of hedges up to 45 inches high.

A Rivet-Cutter of Simple Lines

THE technique of autogenous cutting and welding has made significant advances in the course of the past few years, and more attention is being given than ever before to the perfection of the tools used in this craft. An admirable example is the rivet-head cutter recently put out by the German firm of Dräger, noted for its diving apparatus primarily, and brought into the autogenous field by the development of the diving art. It is designed for quantity work in shearing rivets. A distinctive advantage is that the mouthpiece can be directed against a rivet from any direction whatever—before, behind, or either side. This means that the cutter can be used under any circumstances and on all types of construction. The shoe of the mouthpiece lies flat on the material, and the rivet-head is taken off cleanly, straight across the axis of the rivet and flush with the surface of the material, but without damaging the latter in any way. Heads

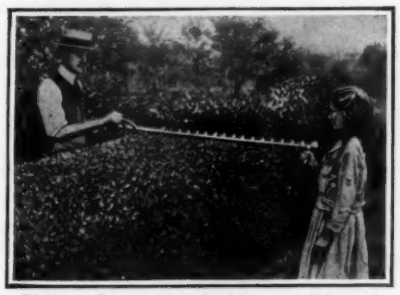
The latest thing in rivet cutters, with a close-up of the mouthpiece that delivers the cutting flame

of all sizes and shapes are dealt with with equal facility. Oxygen or acetylene may be used at pleasure, and from a generator or from compression cylinders as may be desired. Our smaller view shows the mouthpiece, consisting of a copper shoe, a connecting nozzle, and an adjusting screw on the latter; the larger picture shows the burner connected up with the source of gas and in operation.

Alloy Iron Castings

By Edwin F. Cone

ONE of the most familiar materials for many, many years has been and still is the ordinary iron casting. A great variety of objects is made of cast iron, the kitchen stove and the iron fence being some of the most prominent. Cast iron has never been regarded as anything else than plain cast iron. It is and always has been made up of iron for the most part with carbon the principal other constituent together with some silicon, and of course sulfur and phosphorus as impurities.



Giving the garden hedge a quick and easy shave

Of late, however, there has been gradually developing a modification of the plain cast iron casting which promises striking results. It is known as alloy iron castings or iron casting into which there has been introduced certain alloying metals such as nickel, chromium, cobalt, etc. In the analogous industry, steel castings, the progress of this phase has been very rapid so that alloy steel castings, as distinguished from plain steel castings, play a very important role in many industries.

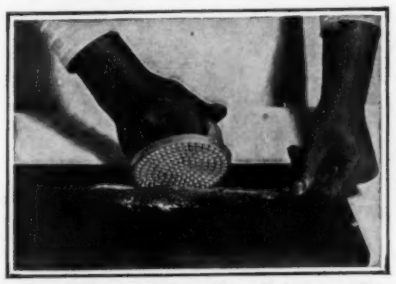
One of the earliest developments in alloy iron castings has been the production of castings from a certain famous grade of pig iron known as Mayari which contains nickel and chromium in natural state in the ore. Iron castings made from such pig iron have of course been alloy castings or nickel-chrome iron castings and have proved satisfactory for rolls and for conditions where wearing quality is a factor. Even for certain motor castings this native alloy pig iron mixed with other iron has proved satisfactory because of sounder metal, easy machine ability and comparatively longer life.

The unusual properties which a 5 per cent content of nickel bestows on iron castings were recently discussed before a large technical society by a representative of a large American electrical company. The product was made in an electric furnace instead of a cupola. It was gray iron alloyed with a 4 to 5 per cent of nickel, which in the proper proportions imparts toughness and pliability to the metal and helps to overcome any tendency of the metal to run white and become brittle because of rapid cooling of the sand mold. The castings referred to, as made of this nickel alloy iron, were what are known as electrical resistance grids. The metal sections are quite uniform for each pattern, but there is among the various patterns a variety of thickness, the cross section varying from ½ by 3/16 inch to as small as ⅛ by ⅛ inch. These nickel alloy grids are found to possess unusual electrical properties and to be capable of being twisted into various shapes, taking a permanent set without breaking—properties not characteristic of ordinary gray iron grids. This alloy has also double the electrical resistance of ordinary cast iron.

Another case where nickel is being introduced into cast iron is the production by a large American motor corporation of iron castings containing from 1 to 1.50 per cent of nickel. The iron is melted in the cupola in this case and the nickel is introduced by placing the required amount of metallic nickel into the inside of some defective or rejected iron casting which, as it melts with the other materials, carries along the nickel with it. The nickel alloy iron castings so obtained are harder and wear better than ordinary gray iron castings.

The Germans have been experimenting with making iron castings containing both nickel and cobalt and some interesting results have been published. Briefly they learned that for the manufacture of high quality castings for machine parts, gear-wheels, etc., a percentage of nickel up to 1.20 per cent insures the best results. So far as the cobalt is concerned when present from 1 to 2 per cent, the effect was found to be the opposite of that of nickel. The bending strength of the resulting alloyed iron drops considerably and the tensile and compressive strength exhibit a gradual decrease while the hardness increases slightly.

Chrome-nickel alloy iron castings have already proved their worth and the presence of nickel alone from 1 to 5 per cent is evidently of lasting benefit also. The foregoing facts point to the role which alloy iron castings are likely to play in the future. While some of these castings can be produced in the cupola which is the old-time mechanism for smelting all gray iron for castings, the electric furnace is necessary in cases where the alloy content is high or a high temperature is required for pouring. It is safe to expect that, with the aid of the electric melting furnace and possibly



The dirty job of scaling fish is made comparatively clean by this little tool

the application of heat treatment, other metals besides nickel and chromium—metals such as molybdenum, vanadium, manganese, tungsten, etc.—may be added to cast iron with good results.

Easy Mounting of Tire Chains

ALWAYS a rather disagreeable task, and rendered more so in direct proportion to the sloppiness of the weather, the attaching of tire chains promises to have much of the kick taken out of it by an invention which we illustrate herewith. Every automobilist knows that the reason why chain-mounting is a messy job is because we have to hold one end of the chain while we manipulate the chain or the wheel or the car so as to bring the other end around to meet it. The present inventor supplies us with a larger edition of the old-time trousers-clip, which we used to snap about our ankles in preparation for a bicycle ride. This clamp squeezes the tire just as its prototype used to squeeze the leg of the wearer; it differs only in having a little

The clamp takes all the punishment out of the task of putting on the chains

hook at each end to catch in and hold one of the side-links of the chain. When both ends of the clamp have been thus engaged its pressure on the tire is sufficient to hold one end of the chain in place while one drives the car a few feet forward and brings the other end naturally and easily around into position for snapping together.

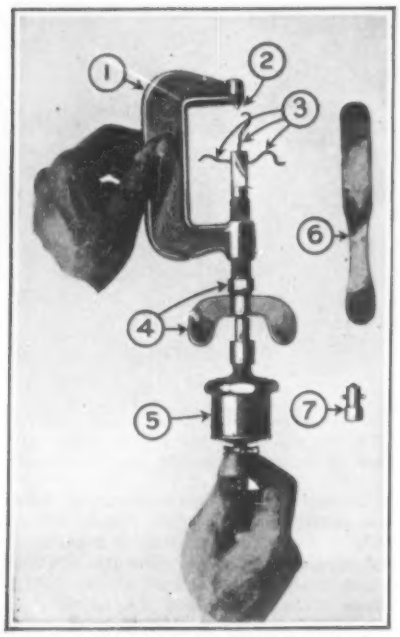
A Scraper for Removing Fish Scales

THE constant reader of these pages of short articles describing minor inventions will have been struck with the fact that a large number of these examples of the inventor's ingenuity are directed at the lightening of the housewife's load. The modern kitchen offers indeed an inexhaustible field and an inexhaustible market to the inventor, and one of which he is quick to avail himself. One of the disagreeable tasks which the butcher might be expected to do, but which he occasionally leaves for the cook is the removal of scales from fish. We illustrate a clever little scraper with which this unattractive chore may be performed with neatness and dispatch.

"Always Fresh"

MANY of us will remember the play of several years ago, in which a considerable part of the action hinged upon the "thrifty" Pennsylvania Dutchman's unwillingness to have bread cut more than a slice at a time, lest a slice be left over to dry out and be wasted. Many more of us will remember how our grandmothers used to pack the cut loaf away with its cut end carefully against the side of the box or the bottom of the crock, for the same thrifty reason. Those of us who still dislike to cut off and throw away a dry slice from the end of the half-loaf in order to come to a moist and edible slice will have our wants met and our recollections of the old home aroused by the "bread-saver" which one of the German photographers shows us herewith. "Immer frisch," says the stamped motto on this little metal cap for the cut end of the loaf—"always fresh."

To keep the cut end of the loaf moist



The latest tool for spreading and greasing automobile springs

For Spreading and Lubricating Springs

AN Indiana manufacturer has recently developed an interesting device for spreading and lubricating the springs of any automobile. The spreading and lubricating is done in one operation by this device. The lubricator body will stand any strain, it is claimed, and will spread springs up to 2½ inches in diameter. A guide pivot on the inner point of the lubricator body spreads inside spring-leaves while a steel leaf-spreader and lubricating nipple spread the leaf and distribute grease in three directions. The spring leaves are forced apart by using a thumb screw or if badly rusted they may be forced by applying a wrench to a hexagon nut above the thumb screw right over the grease cup. The compression grease cup is of a large capacity and forces the grease to the middle of the spring leaf. The steel blade which spreads the lubricant over the entire length of the leaf is very flexible.

Looking for Live Wires

ONE of the first requisites in the process of testing and phasing-out circuits of modern high-tension generating and distributing systems is safety for the operator and the equipment connected to the circuit under test. One severe short circuit due to a failure in the testing equipment or to a mistake on the part of the operator, with its resulting damage or possible loss of life, will prove the false economy of inferior or makeshift testing equipment.

The principle of this detector is simply an indicating lamp in series with a suitable high resistance and a high voltage fuse. The equipment is self contained and has but two exposed contacts to be touched to the circuits under test. Its portability and compactness make it particularly useful in reaching required circuits in confined or out of the way places.

For detecting the presence of high potential the detector is connected directly across phases or one terminal of the detector is connected to a ground bus or any well grounded object and the other terminal is put in contact with the conductor under test. If the lamp glows, the conductor is alive.

A compact outfit for looking for live wires of high potential

The Examination of Textiles by X-Rays

AN interesting addition to the many and varied uses of X-rays in the examination of materials has been developed by Messrs. Truesdale and Hayes in the research laboratory of the Dunlop Rubber Co., Birmingham. In the Journal of the Textile Institute for November, 1921, these authors describe how, by the aid of radiography, they have studied the movement of the threads in the canvas of a motor-tire during the several processes of manufacture of the tire. For this purpose the canvas was specially woven so that every twentieth thread, both warp and weft, had been previously impregnated with a heavy salt. Thus the X-ray photograph reveals a series of squares, the pattern being in the form of a check. The most suitable salt for the purpose was found to be lead chromate formed by precipitation on the yarn by first soaking it in lead acetate and then in potassium bichromate. The X-ray plates or films were placed in actual contact with the material, so that the dimensions of the radiograph were those of the canvas. In the case of a tire the film was placed inside the tire, in contact with the first ply, and held in position by spring clips. The X-ray tube was on the outside, and care was taken that the X-rays were normal to the film. As the series of reproduced radiographs shows, the dimensions of the sides and angles of the squares are affected in some of the processes. By measuring predetermined squares on the radiograph taken after each process the change due to the previous process can be arrived at. The method proves to be an effective means of ascertaining whether the stretch of the canvas threads, resulting from the various processes in the manufacture of the tire, is within the limits of stretch tolerated by the yarn—a point of extreme importance to the tire manufacturer.

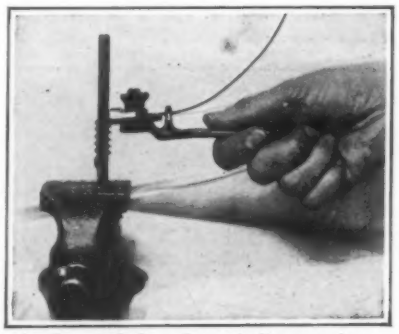
A low-power faucet motor that does a lot of odd jobs

New Spring Drive for Starter Pinion

AN improvement in spring drives for electric starters has been patented. It consists in making the helical spring used with such drives of tapering section, so that it may be comparatively light or flexible when first beginning to wind up and become sufficiently stiff before the engine is broken loose to prevent abutting of the starter pinion against its stop. It is claimed that when the spring is made of uniform thickness throughout, in order to get sufficient flexibility, the spring is sometimes made so light that it cannot withstand the shock of abutment and breaks.

Simple Spring-Winding

WINDING an ordinary spiral spring in the absence of expensive machinery for winding large quantities of springs is not easy to do with accuracy.



A clever dodge for winding springs on a small scale

With the aid of a vise, a metal core corresponding to the desired internal diameter of the helix, and a special winding tool of low cost, however, the trick is quickly turned. The core is fixed in the vise; and the wire of the spring-to-be is curled around it with the utmost neatness and despatch. The little detail of holding the loose end while the winding gets started is taken care of, and one may be sure of getting the spring of exactly the proper size and of exactly uniform curvature and tension in each of its turns.

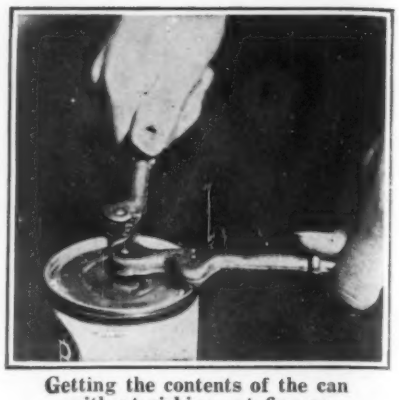
Faucet Motor Grinds, Beats and Polishes

THE kitchen faucet motor, illustrated, with its various attachments will beat eggs, grind the knives, and buff the silver. The egg-beating device is supplied with a flexible shaft that will permit the beater to be taken to a nearby table if desired. A very small stream of water is adequate to run the motor, and ordinary city pressure is said to operate it successfully.

A New Can-Opener

SO that the modern housewife, hotel and restaurant chefs may open canned foods, etc., with ease and without cutting their hands on ragged edges, a new can-opener has been invented. This device will not only open cans easily, but will cut the top off of any tin can, regardless of size or shape, leaving very smooth edges.

The left handle is in one piece with a prong and knife on the under side. The right handle is jointed and has two prongs which act as jaws to grip the rim of the can. Place left handle over top so that the knife comes inside and the prong outside the rim, and press the knife into the can. Open the jaws of the right handle and grip rim of can about one inch from the knife. Holding left handle firm, pull right handle towards left, then away from left until jaws are about an inch away from knife. Take new grip on rim, pulling right handle towards left as before. Repeat this until cover is entirely off. This device is made out of special casting and will not break. The knife found attached to the can opener, when broken or dull from too much usage, can easily be replaced or resharpened for continued service. It is not necessary to touch a can with the human hands for action. The tool is very light in weight and can be carried in one's pocket. In addition to its household use, it makes a tool of extreme value for the camper and the automobile tourist.



Getting the contents of the can without risking cut fingers

To Straighten the Crooked Line

WHEN you admire the perfectly trimmed edge on some attractive grass plot, you may have marveled at the skill of the trimmer. This is the machine that straightens all of his crooked lines. The cutting blades are made of high-carbon steel and are so set, at a slight angle, that they sharpen themselves. The lower disc develops a speed of 3,000 revolutions per minute, cutting a twig ¼ inch through. Tough grass has no terrors for it, so its inventors tell us. Handles are adjustable, fitting the tall or the short workman; and on every ground it seems that this apparatus would constitute an addition to anybody's kit of gardening tools.

An up-to-date tool for straightening the edges of the lawn

Our Readers' Point of View

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

"Doctors and Near-Doctors"

To the Editor of the SCIENTIFIC AMERICAN:

I wish to thank you for the splendid editorial on chiropractors. When those of us who practice medicine say such things, the man in the street cannot help wondering if there isn't some personal animus or jealousy behind it all; when a layman of unquestioned scientific authority says it, there can be no doubt.

We have soon to fight, in California, a law which will put correspondence-school doctors on the same footing with the regular profession. I think what has always bothered me most about letting down the bars to such ignoramuses has been that it disorganizes the fight against disease which is waged by public health authorities. I often think of what would happen to a modern army if there were scattered through the various corps, often in strategic positions, men and officers who had had no training in the technic of modern warfare—signal corps men who did not know the Morse code and officers who did not know "column right" from "column left oblique."

As a teacher in the University of California Medical School, I appreciate the great difficulties of turning out fairly acceptable physicians after four years of high school and eight years of college training. As you know, the specialists have to spend many years more in perfecting their technic. It is strange that even well educated, otherwise intelligent men, simply cannot see the dangers of putting their lives in the hands of a man who, a few months before, was a chauffeur or a cook.

WALTER C. ALVAREZ,
Assistant Professor of Research Medicine.
University of California.

To the Editor of the SCIENTIFIC AMERICAN:

I read with interest your editorial on chiropractic. I have attended two chiropractic schools, and find all that you say well taken. As regards your exposition of the sheer impossibility of one's failing to get one's degree from these schools, I would trespass on your space to outline the manner in which final examinations were given at these schools.

At the first chiropractic school which I attended, I noticed that for some time before the examinations each lecturer prefaced each day's work with a brief intensive quiz, going over in this way the same ground every day, day after day, until every member of the class was thoroughly familiar with the material of these questions. A few days before the examination two of the seniors explained to me that this material constituted the list of final-examination questions; and when examination day arrived I found it so without a single exception. I saw three final examinations in this school, all conducted on this basis of prior knowledge of the questions to be asked.

Later I matriculated at another school, making no claims for credit. Here the scheme was somewhat different. Two or three weeks before the end of the term, the class president circulates a petition to each instructor, signed by the entire class membership, and praying that he submit his list of questions for examination. After some affable hesitancy this is done. Each professor writes on the board a list of 20 to 40 questions, and the final examination consists of 10 or 15 selected from these. Some day, I suspect, there will be a particularly stupid student who will flunk in spite of this system; and then the freedom of the instructor's choice after having published his tentative list will have to be further restricted. They've got to get their degrees, you know!

The only requirement in either school for entrance was the ability to read and write; but no mention is ever made of how well these fundamentals are to be performed. And beside this cult Einstein is a mere piker. Fifteen minutes becomes an hour; and as if this demonstration of the relativity of time were not enough, I know that I was credited with hours of work that never had any existence at all except in imagination. If time is the fourth dimension, perhaps this is the fifth!

Dallas, Texas. JAMIESON, M. D.

To the Editor of the SCIENTIFIC AMERICAN:

After reading your editorial "Doctors and Near-Doctors," I want to thank you for so fully expressing your point of view. It would be well if everyone could be brought to understand that in his opposition to these cults with their quick-and-easy roads to a pseudo-medical practice, the orthodox physician is moved entirely by considerations of justice and public health.

As students of anatomy and physiology we of course admit the existence of the bones comprising the spinal column, of the brain, of the spinal cord, of the nerves therefrom. But we deny that so many human beings as are diseased are deformed in the arrangement and articulation of their spinal vertebrae, or that diseases in any but insignificant numbers are caused by simple misplaced pressures on spinal nerves. If the causation of illness is as simple as all this, why do we spend millions of dollars every year on the disposal of garbage, the quarantining of infectious disease, the inspection of the physical condition of school children, the maintenance of hospitals, the support of the Red Cross, the anti-tuberculosis campaign, and all other constructive and preventive activities which modern research has devised? When chiropractic is legalized so that its practitioners can diagnose and treat all diseases on their own initiative entirely, including those dangerous to public health, according to their simple formulas, all this accumulated experience of years goes to naught.

Greenfield, Mass. B. P. CROFT, M. D

To the Editor of the SCIENTIFIC AMERICAN:

If the chiropractor really believes that susceptibility to disease is a matter of misplaced spinal units, and that a perfect spine confers complete immunity, he can prove it easily enough. Let him get his backbone thoroughly overhauled by his brother practitioners, until they are agreed it is in perfect trim. Let him then expose himself to one of the malignant diseases under conditions which orthodox medicine says will lead to infection—the bite of the yellow-fever or malaria mosquito, the consumption of typhoid or diphtherial food, etc., etc. And let him not balk at the test, which has been undertaken more than once by doctors—and not under conditions alone which they believed would make them immune, but under conditions which they believed would lead to infection. Let the chiropractor stand ashamed in the presence of Reed and Lazear if he declines this issue.

Step right up gentlemen, the line forms on this side.

New York. AN INTERESTED LAYMAN.

To the Editor of the SCIENTIFIC AMERICAN:

May I take exception to some of the statements in your editorial "Doctors and Near-Doctors"?

I am 40 years old. Up to September, 1921, I had never known a minute free from headache, which at times became so bad as to confine me to bed. Doctors in Baltimore, Washington and other cities treated me without even temporary relief; doctors of eminent reputation who, I must believe, did their best for me. The best eye specialists had similarly failed.

During July, 1921, I took chiropractic treatment aimed at a general run-down condition. After a few treatments the headaches were better and in September disappeared entirely.

The same rule applies to chiropractors as to any profession. There are good and bad in the lot, and it is unjust to judge all by the few.

Referring to specific statements in your editorial, I would say, first, that if the investigators of chiropractic were unbiased and were competent radiographers, a difference would plainly be shown in views of a spine before and after chiropractic treatment. [*This assumes an honest chiropractor and a real "subluxation," and has no bearing upon the case cited.*—EDITOR.]

Many States have had legislatures broadminded and independent enough to license chiropractic. In this connection, would it be just and fair to require chiropractors to pass an examination in medicine which they do not prescribe and are not permitted to use? [*Passing over the doubtful propriety of attempting to treat all ailments without the use of drugs, we should say no. But it would be just and fair to examine them in anatomy, hygiene, bacteriology, and all allied subjects which are prerequisites of competent diagnosis; and it is these subjects that take up the bulk of the time spent by the physician in preparation.*—EDITOR.]

It is true that many chiropractors have no medical training. Many others have this training. Some men who have practiced medicine and surgery have been broadminded enough to investigate a new method of treating human ailments, and are now using with their own practice some of the methods advanced by the chiropractors. [*That is the way chiropractic should be used; on the prescription of a competent physician or surgeon. A barber can remove a facial growth; but a cautious man would hardly let the barber diagnose the propriety of removing it, or tell him whether it was a wart or a cancer or a means of discharge of blood impurities. The distinction between diagnosis and practice is the distinction between unsafe and safe chiropractic.*—EDITOR.]

Doubtless a chiropractic *did* make a wrong diagnosis. So do doctors, and in far greater numbers [*though probably not in greater proportions.*—EDITOR.] A very prominent physician recently estimated that 60 per cent of medical diagnoses are wrong. Further, the leading chiropractors, and there are many, do not claim to cure all diseases. [*They are false to their teachings as we understand the latter; but we will pass that point up in commendation of their rational personal attitude. Doubtless that is why they are the leading members of their cult.*—EDITOR.]

There are certain schools of chiropractic that do not measure up to the standard, but the same applies to certain schools of medicine, of engineering, of law, etc., etc. For this reason, are all to be judged by the lower scale and the profession as a whole condemned? And what if the man mentioned in one place was a chauffeur six months before? Was there any attempt made to find out how long he had been studying in the attempt to better himself? Are we to place a ban on the brains of all men who have been guilty of manual labor? In connection with his working his way through the medical school, you might know a man in Washington as a watchman or a waiter, and meet him a few months later as a practicing physician in some other city.

Cherrydale, Pa. CHARLES G. BARTON.

[*We apologize to Mr. Barton for the interpollations in his letter. They are the most economical method of meeting certain of his points that seem to leave the way open for an answer; and space on this page, this month, is at a premium.*—EDITOR.]

To the Editor of the SCIENTIFIC AMERICAN:

Both myself and my wife have been treated with success by chiropractic—I for constipation of many years' standing, she for severe eye pains. If you will go back to your text-book, I think you will find that you are only partly right when you say that the nerves to the eye never leave the skull. Two sets of nerves supply each organ. The true chiropractor makes no pretense of operating on the optic or auditory nerves that do the sensing, but he will tell you that most eye and ear troubles are from the other set of nerves, branching off about the third vertebra, and that it is only troubles due to these nerves that he attacks. My chiropractor has sent a case of the other sort to an oculist, admitting that it was outside his own field.

Your knee case is doubtless true. But are you not going to make allowance for quacks here as in other fields? [*Mr. Best might have made this remark strike nearer home by suggesting that there are quack editors, too, but that we would hardly care to go in the same classification with them.*] As an offset to the knee case, permit me to mention another case of a young-lady acquaintance who was condemned by the regular doctors to become a hopeless cripple from inflammatory rheumatism. Chiropractic cured her completely in six months.

Walhalla, N. D. S. G. BEST.

To the Editor of the SCIENTIFIC AMERICAN:

Your editorial "Doctors and Near-Doctors" has brought both pleasure and pain. Pleasure, because you have had the courage to strike at this abuse: pain, because you have not stuck to the central theme at issue, as I see it.

The Christian Scientist denies that certain diseases exist. This is contrary to common experience and the teachings of science. We permit the Scientist to practice, and his success in dealing with certain types of illness demonstrates his right to practice. But our laws regarding manslaughter hedge him in very closely when he comes to deal with organic disorders of bacteriological origin like tuberculosis, scarlet fever, etc. We know something about the origin and reality of these diseases, different from what the Scientist believes; and we do not permit him to foist off upon the public his beliefs.

You come closest to the heart of the matter when you say, in effect, that chiropractic doubtless has some merit, like osteopathy, hypnotism, Christian Science, massage, and mud baths; but that the immediate concern is to see that these cults do not overstep their proper bounds. And the place where these bounds are most easily overstepped, and where it is at the same time most essential that they be maintained, is in diagnosis.

The chiropractor will claim that he doesn't give drugs, and that he should not be obliged to spend a lot of time learning the technique of drugs. This we can admit. But he will, by implication, also claim that he does not believe in germs, and that he should not, therefore, be asked to bother his head about germs—or, similarly, about anatomy beyond that of the spine, about hygiene, about dietetics, about any of the multitudinous subjects which make up the bulk of the medical course.

If the chiropractor will confine his activities to tickling the backs of persons for whom a competent diagnostician prescribed back-tickling, well and good. But he won't do this. He casts aside all the data on which the physician makes his diagnosis, and then proceeds to diagnose for himself. This is what hurts. If the practitioner, whatever his cult, is to be permitted to make his own diagnosis and to decide for himself whether to apply his own peculiar treatment, he must, in defense of the public health, have the same background of general information which the medical practitioner has. And he can't get it in less time than a doctor gets it. Nor can he be permitted to argue that his very ignorance is a virtue, and that because he doesn't believe the earth is round he ought to be permitted to steer a ship on the assumption that the earth is flat. We can't prevent him from believing that the earth is flat, to follow out the figure, but we can keep him away from the wheel so long as he holds that belief.

Chicago. JAMES SMITH.

A Philippine Sugar Mill

FROM time to time we have shown in these columns pictures of the latest thing in sugar machinery and views of giant modern mills. That the industry has not always been on such a plane as these indicate is made clear by the photograph herewith, which depicts a sugar mill in the interior of the Philippine Islands. In this part of the world sugar-making is still in the hands of natives to a large degree, and the work is carried on in the most primitive fashion. The production of such mills as the one shown figures in the foreign trade of the islands to a surprising extent. It goes without saying that its operations are far from economical, and that capitalization of the Philippine sugar industry would greatly expand its production.

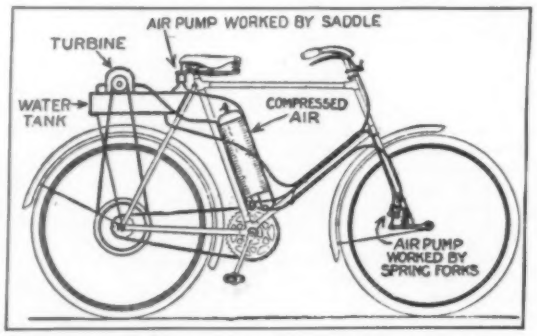
Primitive sugar mill of a type common in the Philippine Islands

The Bounce-Power Bicycle

FROM an issue of the *Westminster Gazette*, staidest and most dignified of London's conservative sheets, we copy one of the most amazing mechanical devices that has ever come to our attention outside the pages of the comic weeklies. According to the claims made for this apparatus, cyclists are promised a bicycle which will be self-propelling, running without fuel consumption or other expenses of any kind save wear and tear.

The machine, which we illustrate from the "inventor's" drawing, works through the actuation, by oil or water under pressure, of a small turbine geared to the rear wheel. This pressure is to be maintained by the weight of the rider, acting on a small pump. The latter is substituted for the ordinary saddle springs, and answers the same purpose of absorbing shock. A small cylindrical tank is fitted to the tube holding the saddle pillar. Air is pumped into this tank. Immediately beneath the saddle is the tiny pump, worked by the weight of the driver when the machine is in motion. Oil is drawn from another tank, mounted on a rear carrier, and is pumped into the air chamber, so that the air is further compressed during the journey. A control lever on the handle-bar opens a valve which allows the oil to flow from the air chamber to the turbine which is situated over the oil tank on the rear of the machine. A chain from the motor drives the rear wheel, and the used oil returns to the tank.

Our contemporary gravely announces that this apparatus "has passed through the experimental stage, and is now in process of manufacture," and that the makers are being "hurried up." It adds, however, the saving admission that "so far a bicycle with the new equipment has not been tested on the road." We should piously hope not. The statement is made that with a rider of 140 pounds the machine will develop between three-quarters and one horsepower. It is not entirely clear to us whether the inventor is a simon-pure perpetual motion illusionist, who believes that gravity can be harnessed in this fashion; or whether it is his idea that the power for driving the machine is to be generated by the up-and-down motion of the rider which would ordinarily be damped by the springs. If the latter theory is the one which he is pursuing, we are moved to wonder just what effect the developing of one full horsepower by contact between the human anatomy and a leather saddle would have upon the portion of the anatomy making the contact. And what is the unfortunate rider to do when he strikes the ideal smooth stretch of road—the bumpless pavement?



The latest in perpetual motion—a bicycle intended to be driven by the impact of driver with seat

Heat Treatment of Drill Steels

PAST work in this field by the Bureau of Mines has been continued, and its scope extended. The breakage of drill bits in use constitutes an important part of mining costs, and the object of this work is to determine the causes of breakage and to find means for their elimination.

The Mississippi Valley experiment station, which has its headquarters for field work at St. Louis, Mo., and its laboratories at Rolla, Mo., is cooperating with the Minneapolis station in the investigations of drill steels.

In the course of the rock-drilling and drill-steel investigation in the Tri-State District, work has been started to find out the most efficient change of gage to use between different lengths of steel. Present practice favors changes of from one-fourth to three-sixteenths of an inch, but it is planned to try changes as small as one-sixteenth inch. A reduction in gage means decreased drilling cost, as the work of drilling varies with the size of the hole. It is also planned to try out smaller sizes of drill steel. The size of drill steel now in use in this district is 1¼-inch round. In several other districts where the large size was formerly used the same work is being done with smaller steel, thus reducing the cost of the steel, lessening the work of the miner in transporting steel, and increasing the drilling speed. Steels one inch in diameter will be tried and results will be compared with tests with the larger steel. The results thus far indicate that the 1-inch steel can be used successfully and that a considerable saving in drilling cost will be effected.

Blast Furnace Studies

GOVERNMENT metallurgists have been busy with investigations of blast-furnace reactions as related to low-grade manganese ore now available in the United States. Fundamental data were collected and used as a basis for future experiments. Experiments have been conducted on the flow of gases and the flow of stock in blast furnaces. Other subjects of investigation have included the following: Volatilization of manganese in the blast furnace; history of blast-furnace lines, shapes and sizes; the rate of reduction of iron oxide by carbon monoxide gas; the production of high-silicon pig; charcoal iron-furnace practice.

The Bureau of Mines station at Seattle has been engaged in making a general survey of the iron and steel situation in the Pacific Coast States, with regard to consumption of iron and steel and the supply of raw materials for their manufacture. The results of this survey have indicated that a preliminary reduction of the iron ore to sponge iron, with subsequent melting in the electric furnace would be peculiarly fitted to the needs of the Pacific Coast, and considerable progress has been made in experimental work in developing this method to a commercial basis.

Attempts have been made to produce foundry iron by melting sponge iron that represents the product to be expected from commercial operations. Methods for the introduction of carbon into the metal and the removal of the large amount of sulfur introduced during the preparation of sponge iron were studied. Encouraging results were obtained and further work is in progress. Methods for the preparation of sponge iron have also been studied, and small-scale tests were made to determine the best conditions, such as the temperature, size of ore and reducing agent, kind of reducing agent, and furnace conditions. This work is being continued on a larger scale with the object of developing a furnace for the commercial preparation of sponge iron. Magnetic concentration proved to be the best method for removing impurities from the metallic iron in the sponge iron.

The Luminaire?

CALLING attention to the fact that large numbers of lighting fixtures are not at all fixed, and that the term "lighting unit" is clumsy, the Illuminating Engineering Society advocates the deliberate adoption of a new word to take the place of "fixture," "lighting unit," etc., and to signify anything in the way of lamps, globes, reflectors, and so forth. The French word luminaire is recommended for this service on the ground that it is not a coined word, and that the sense will be plain to all users of English.

Finding Practical Work for Low-Grade Ores

THE work of the Bureau of Mines on iron ores is directed chiefly toward devising means for utilizing extensive deposits of low-grade ores that cannot be smelted profitably by present methods. In order to utilize such ores, it is necessary that enough of the gangue and impurities be removed to raise the ore to smelting grade, or methods of smelting ore of lower iron content must be devised.

The North Central mining experiment station of the Bureau of Mines, at Minneapolis, Minn., has continued to cooperate with the State mining experiment station in an investigation of the reserves of low-grade ore in the Lake Superior district, and in milling tests of samples collected in the course of the field work. This work has also included experimental tests of low-grade iron ores in the southern districts. With the establishment of the mining experiment station at Birmingham, Ala., more extensive work has been made possible, and a comprehensive survey of the iron and steel industry of the Birmingham district has begun. The main object sought is to develop means of beneficiating the low-grade highly silicious ores that occur in large quantities in that district. At Minneapolis the work has been more closely related to utilizing low-grade manganiferous ores of the Lake Superior district, particularly as regards the study of blast-furnace practice.

Snow plow, particularly adapted for park use, that throws the snow across the sidewalk and piles it up on the lawn

Plow That Banks the Snow

ALL snow plows create more or less of a cloud of flying particles in their wake, but it has remained for engineers of the South Park Board of Chicago to take advantage of this trait. They designed two years ago a plow that sweeps clean a seven-foot pathway, taking the snow into the machine and then throwing it in a cascade that deposits it on the park lawn, well clear of the sidewalk. The shower of snow, it is to be emphasized, is hurled clear over the sidewalk, and on the lawns where it is thus deposited it can lie indefinitely without any inconvenience. If found necessary, the machine can throw the snow no less than 200 feet—but this extreme performance is doubtless more in the nature of a stunt than a real utility. Since its introduction in the winter of 1919–20 the plow has been given plenty of hard use, and has stood up well to the work.

The Service of the Chemist

A Department Devoted to Progress and Achievement in the Field of Applied Chemistry

Conducted by ISMAR GINSBERG, Chemical Engineer

New Protective Agent for Wool and Silk

IN the treatment of wool in the alkaline scouring bath, there has always been considerable danger that the alkali will attack the fiber and destroy its strength and detract from its original lustre. Just how strong a solution of alkali can be used without danger, how long the wool must be allowed to remain in the solution, and the other factors which influence this action on the wool, are fairly well known but not generally applied in actual practice. Likewise the degumming of silk in an alkaline bath is fraught with danger to the fiber itself.

Recently a new product was put out on the market by the Aktien Gesellschaft fuer Anilin Fabrikation of Berlin, under the name of "Protectol," which is used in the scouring and degumming processes, where alkaline reagents are employed, to protect the animal fiber from injury. The product comes in the form of a syrup which is readily soluble in water. Its composition is still unknown. The quantity used in the alkaline bath corresponds to half the amount of soda ash employed. When this substance is added, the alkali does not have any injurious effects on the wool at all. Silk can be rapidly and safely degummed in an alkaline bath without damage to the fiber and with a great saving in steam and labor.

Synthesis of Allyl Alcohol

A REPORT was recently made on an important piece of research work, performed on the synthesis of allyl alcohol, before the Society of Dyers and Colorists at Leeds, England. A process was worked out for accomplishing this synthesis, which has great commercial possibilities, and which may receive industrial application before long. The importance of allyl alcohol lies in the fact that from it there may be obtained by a simple process, easily carried out on a commercial scale, the important product glycerine. Treatment of the alcohol with an aqueous solution of potassium permanganate brings this about. For further details see the *Chemical Age of London*, March 25, 1922, page 288.

Calcium Chloride as Dust Preventative

THE use of calcium chloride as a dust preventative on gravel roads is being considered by the American Society for Testing Materials and the Department of Agriculture, so as to arrive at standard specifications for this material if its use is recommended for this purpose.

Magnesium Sulfate as Fertilizer

ONE of the components of chlorophyll, the green coloring matter found in all plants, is magnesium; consequently the question has been raised as to the significance of magnesium in the process of building up plant structure through photosynthesis. Many potassium fertilizers contain some magnesium, and it may be that the good results that have been obtained with these fertilizing materials is due in part to the presence of magnesium in them. Recently some important work has been done in Germany along these lines, to determine the fertilizing value of magnesium salts, if any at all. Scientific work performed with various magnesium salts in the cultivation of potatoes has revealed the fact that the sulfate is the best of the magnesium salts for this purpose, and under some conditions distinctly better yields have been obtained by additions of this salt to the land. Further work has still to be done before the real value of magnesium sulfate as a constituent of fertilizers may be determined.

Bread from Soya Bean Flour

ACCORDING to a report, appearing in the Bulletin of the Japan Society, Japanese food chemists are busy experimenting with the production of a palatable bread from soya bean flour. Soya bean is the well known source of soya bean oil, which finds extensive application in the paint and varnish industry. The report states that a digestible and palatable bread has been made successfully from this flour, and at a price which is considerably below that made from any other kind of flour.

Decolorizing Char from Bagasse

BAGASSE is the refuse material, which is recovered after the extraction of the sugar juice from the cane. Heated to a temperature of 900 degrees C., it is converted into a charcoal, which has a decolorizing power of 66, in comparison with standard bone charcoal at 100. This was increased to 86 by boiling with caustic soda and to 170 by subsequent boiling with hydrochloric acid. This is a very noteworthy fact. Besides possessing a marked power of removing organic coloring matters, bagasse charcoal is able to absorb iron salts from solutions to a marked degree. Yellow commercial hydrochloric acid, treated with this char, comes through perfectly colorless. This suggests a possible technical application of bagasse char. For further details see *Journal of Industrial and Engineering Chemistry*, April, 1922, pages 295 to 298.

Gas from Leaves

LEAVES, all sorts of wood waste, pine needles, kitchen refuse, straw, waste tan-bark have been used as combustibles in the production of gas in Germany. Particular attention has been given by the Deutsche Gas Aktiengesellschaft of Hanover to the production of a gas from leaves. This product is a permanent gas and may be transported from place to place in pipes. It possesses a calorific power of 3500 calories which compares well with an illuminating gas made from coal with a calorific power of 5000 calories. Gas made from leaves has been used successfully in the same kind of lighting and heating devices commonly employed with illuminating gas and water gas. The new product does not contain any ammonia, sulfur or cyanogen compounds, and hence does not have to be purified before usage. It can be produced on a large scale in central plants or in small scale generators in farm houses and isolated buildings, to which gas cannot be conducted.

Artificial Cow's Milk from Plant Milk

A MILK is extracted from certain oil seeds, which contain the greatest possible portion of the nitrogeneous substances that are originally present in the seed itself. This product is secured by adding quartz and emery to the oil seeds and extracting the milk by passing the mixture through a centrifugal machine. From 100 grams of seeds there is obtained one liter of the milk, which has the following composition: 2 per cent nitrogeneous substances, 3.5 per cent of fat, 90 per cent water, 2.5 per cent of carbohydrates and 1 per cent mineral salts. The milk is about two-fifths as cheap as common cow's milk. Certain ferments, the nature of which is not disclosed, when added to the milk, give it a taste which resembles that of cow's milk very closely. This artificial product is easily digested and possesses likewise the coagulating properties of cow's milk. Hence, it can be converted into various sorts of curdled and fermented milk products. For further details, see *Seife*, 1922, page 567.

Linoleum Substitute

A SUBSTITUTE for linoleum and artificial leather is obtained from metallic naphthenates and rosin to which vaseline oil, or rosin oil has been added. A typical mixture of these constituents contains 50 parts of aluminum naphthenate, 25 parts of rosin and 25 parts of rosin oil. The product is not friable nor brittle. Chromium naphthenate may be used in the place of the aluminum salt and other metallic naphthenates such as calcium, magnesium and zinc. In this case it is not necessary to add rosin, copal or drying agents, but merely cork meal or wood meal and mineral colors. For further details the reader is referred to *Kunstoffe*, 1922, page 34.

New Radium Mineral

THE discovery of a new radium mineral, for which the name Dewindtite has been suggested, is reported from Kasolo in Belgian Congo. The mineral is yellow in color and the pure canary yellow crystals have a high radio-activity.

Copper Used in Welding Iron and Steel

IRON and steel parts are welded together by means of copper in a new process recently introduced in England. The copper forms a very thin skin on the iron or steel part, when it is heated thereon to its fusion point in an atmosphere of hydrogen. The copper actually penetrates into the very fine pores of the iron and forms a very firm weld.

Titanium White Enamel

IT has always been thought that the addition of cobalt oxide to titanium white would yield a yellowish green mass under any conditions of admixture. According to an article in the publication, *Gewerbefleiss*, 1922, number 2, this is not the case, when the cobalt oxide is added in small amounts under conditions described therein. An almost perfect white enamel is made in this way.

Rubber Latex in Paints

THE search for new uses of rubber goes on. Not very long ago it was announced that rubber latex, that is the uncoagulated juice obtained from the rubber tree, has been used successfully in making a new sort of paper by mixing the latex with the pulp in the beating engine. Now, it is reported from the same sources, that is from England, that experiments are under way to make an entirely new type of paint and varnish with novel and advantageous properties by admixing rubber latex with the oils and pigments and other materials usually used in making paints and varnishes.

Adhesive from Castor Bean

THE Committee on Adhesive Research in England has just announced that the castor bean, after it has been freed from its oil content, can be used for the manufacture of a good grade of adhesive, which finds use in the preparation of plastics, in dyeing, etc.

Recovery of Radium from Luminous Paint

THE amount of radium in luminous paint is extremely minute, but in spite of its minuteness it is still recoverable according to a process described in the *Journal of the Society of Chemical Industry*, 1922, pages 95T to 96T. Luminous paint is used to coat dials and indicators of all sorts, and in the course of time the paint decays but the radium remains unimpaired. The recovered radium is of a very high purity.

Buttons and Buckles from Paper

BUTTONS, buckles, ornaments used in trimming hats, etc., have been made in Austria from hard paper or cardboard by a new process, recently developed to a commercial state. The articles are first made from the paper and then impregnated with gelatine or a solution of varnish or lacquer and then treated in a bath of formaldehyde, which hardens the gelatine. Another method is to treat the paper first and then stamp the various articles from it by a special process.

Turbidity in Varnishes

THE clouding of varnishes in the can is a well known phenomenon and is the cause of numerous complaints from the users of varnish. The painter is much disturbed when he opens his can of varnish and instead of seeing an almost transparent product, he finds a cloudy mixture which does not work well with the brush and does not give the results that a good varnish should. In the *Paint, Oil and Chemical Review* of April 5, 1922, there is given an explanation to show why varnishes become cloudy during manufacture or during storage and also certain directions to follow to avoid this happening. The experiments made indicate that the cause is not to be found in the nature of the amount of rosin or drier, but in the use of lead.

Carbonization of Lignite

IN these columns we have previously noted the activities of our Canadian friends in the carbonization of lignite, a progress report of which was made at the September meeting of the American Chemical Society of Chicago. Previous to the Canadian work extensive large-scale experiments were carried on in North Dakota, and it is now announced that the Bureau of Mines has completed arrangements for cooperative research there on the carbonization of lignite. The Bureau of Mines will be in charge of the technical and experimental features, while the funds necessary are to be supplied by private interests.

The Heavens in August, 1922

The International Astronomical Congress and Some of Its Noteworthy Results

By Professor Henry Norris Russell, Ph.D.

THESE lines are written on the concluding day of a great astronomical conference—the first session, since its organization in Brussels three years ago, of the International Astronomical Union. Its meetings have brought together three or four score astronomers, and perhaps as many more students of the sciences which are now grouped under the new heading Geophysics (geodesy, seismology, terrestrial magnetism and the like). Seventeen nations (counting the various British Dominions) were represented; and the proceedings, when formal votes were necessary, had to be conducted in three languages—English, French and Italian. Almost all those countries which took part in the war on the Allied side, or were neutral in the great struggle, are already represented—the thorny problem of relations with former enemies being for the present deferred.

A delegate to such a meeting has grounds to realize how influential a position science occupies in the world of today. Distinguished courtesies have been shown the delegates to scientific conventions in past years, and in many lands; but it is doubtful whether any previous reception has equalled, or whether any in the future could excel, that which the Eternal City has afforded. Nor is all the tale thus told; for, though all roads lead to Rome, there is much to see on the way—one astronomer found that Jerusalem was conveniently on the route from Boston to Rome!—and almost more to see in Rome itself, before or after the meeting.

But these things, however they may emphasize the dignity of the position which science occupies, or contribute to the health and happiness of the delegates, are but the setting which surrounds the real purpose of the conference. Most of the time of the delegates during the week of sessions was occupied with serious work, and this week of work represented only the finishing touches upon a far greater amount of important labor.

As in all similar bodies the main part of the work is done in committees—and the Astronomical Union had no less than thirty-two of these, each charged with the discussion of some particular phase of the science and composed of men picked for expert knowledge in this field. In a few cases it was found that little need for formal international cooperation existed—for example, in the field of Relativity, where advances must necessarily be made by individual investigators, born and not elected. But most of the committees found a real field for activity in matters where international agreement is of importance.

For example, the Committee on Units and Notation, under the presidency of the Belgian astronomer Stroobant, found that in speaking of the absolute magnitude of a star (that is, the magnitude which it would exhibit if viewed from a standard distance) no less than five different standard distances were in use among astronomers. They recommend that only one of these, corresponding to a distance of ten parsecs, shall be used in the future. This same Committee recommend that the Latin names of the constellations be used in all scientific work. This represents a courteous concession on the part of the French, who have always used the names in their own language. Again, a set of abbreviations for the constellation names has been adopted, reducing them to three letters each, which will save many hundreds of dollars per year in the expense of printing catalogs and tables.

Where Cooperation Counts

The distribution of astronomical telegrams, announcing discoveries of comets and the like, has for the past few years been carried on through three centers: Harvard for the western hemisphere, Brussels for the Allied countries, and Copenhagen for the neutrals and the Central Powers. At the request of the Royal Belgian Observatory, its share of the work has now been transferred to Copenhagen—considerably diminishing the total volume of clerical labor that is required.

In the field of solar physics note may be made of the adoption of an extended table of standard-wave-lengths of lines in the spectrum of iron, prepared with great care by Dr. St. John, using the combined results of nine investigators in different countries. Without such standards, it is impossible to tell, if two observers find different positions for the same spectral line, whether the difference is real or due to their use of different standards of comparison: but such difficulties will now be removed.

Certain important matters which involve both the study of the heavens and that of the earth, such as the variation of latitude, and the exact determination of terrestrial longitude by wireless or otherwise, have been put in the hands of joint committees composed of astronomers and geophysicists—which offers promise of more rapid advancement than either could make alone.

In the field of stellar astronomy the Committee on Parallaxes reported that a general catalog of reliable determinations of the distances of the stars, up to the present date, is in preparation at the Yale Observatory by Professor Schlesinger. Its publication will be a great boon to all investigators of this subject, who now have to wade laboriously through volume after volume of miscellaneous publications to collect the data for themselves.

The Committee on Photometry, headed by Seares of Mount Wilson, reported a list of standard magnitudes of stars near the north pole, which depends upon the work of so many observers, agreeing so well, that it may safely be adopted in future as a primary standard, which any astronomer can utilize by photographing the region of the pole, and the stars he is investigating, on the same plate.

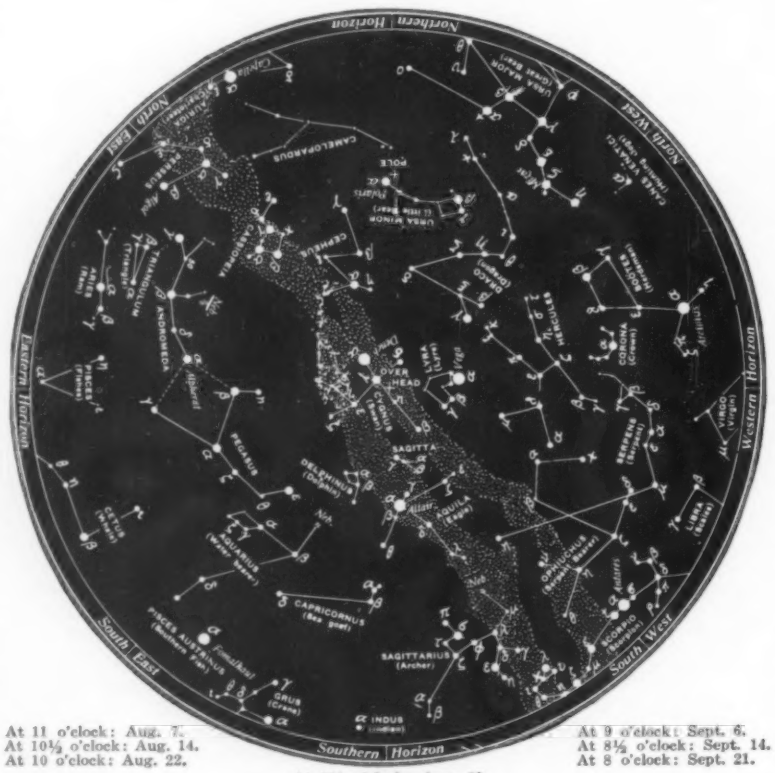
The Committee on Double Stars presented many valuable suggestions to observers, and reported on the progress of the new General Catalog of variable stars, which is under preparation by Professor Aitken at the Lick Observatory. The Committee on Variable Stars itself is still busy, and will be for the next two or three years, with the preparation of important summaries of the ways in which work can best be done, and lists of the stars which most need observation. One part of this work—the prediction of the eclipses of variable stars of the Algol type—will be undertaken in Poland by Professor Banachiewicz—a welcome indication.

The Committee on the Classification of Stellar Spectra has expanded the familiar "Harvard system" of designation (without altering it or interfering with its use as it now stands) so that far more information regarding the character of a star's spectrum can be expressed in small compass than has previously been possible. Practically all known stellar spectra, even the most unusual, can be classified in some way under the new scheme.

Finally, a Committee on the Reform of the Calendar, after making an excellent and impartial report upon the various schemes in existence—ranging from the mere alteration of the lengths of a few months by a day or two, up to the introduction of thirteen months of four weeks each plus an additional day (in leap years two days) to be a part of no month—asked to be disbanded, as no action seemed desirable at present.

In several cases the committee reports as they stand would be regarded as papers of unusual importance, had they appeared independently in the foremost astronomical journals. In other cases work of equal importance will soon be forthcoming. Such activities form the real achievements of the Congress.

It remains to add that the next meeting of the Union, which convenes triennially, will be held at Cambridge, England, in 1925. An invitation to the United States for 1928 was cordially received. Professor Baillaud, the distinguished director of the Paris Observatory, and the first president of the Union, has retired on account of his advanced age, and Professor Campbell of the Lick Observatory has been chosen in his place. The five vice-presidents illustrate the world-wide sweep of the organization—Hough of South Africa, Deslandres of France, Cerulli of Italy, de Sitter of Holland, and Hirayama of Japan. The committees, almost all of which have been continued, with many strengthened by the addition of new members, are even wider in their geographical scope, and include a large majority of the principal workers in their various fields. Their work in the next three years will be awaited with even greater interest.



At 11 o'clock: Aug. 7.
At 10½ o'clock: Aug. 14.
At 10 o'clock: Aug. 22.
At 9½ o'clock: Aug. 29.
At 9 o'clock: Sept. 6.
At 8½ o'clock: Sept. 14.
At 8 o'clock: Sept. 21.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on August 7, etc.

NIGHT SKY: AUGUST AND SEPTEMBER

The Planets

Mercury is in conjunction with the sun on the 7th, and becomes an evening star, theoretically; but he does not come into sight until the close of August, when he may perhaps be glimpsed in the twilight—though Saturn, setting half an hour earlier, may easily be mistaken for him.

Venus is an evening star, setting at about 10 P. M. on the 1st and 9.30 P. M. on the 31st, and very conspicuous. On the 13th she is in conjunction with Saturn, and on the 26th with Jupiter, at a distance of about 2½° in each case.

Mars is in Scorpio and Ophiuchus, receding from us and growing fainter but still a very fine object. He is due south just after 8 P. M. on the 1st and just before 7 P. M. on the 31st, so that he is well placed for the casual star-gazer.

Jupiter and Saturn are evening stars in Virgo, still about 10° apart, and very conspicuous. Uranus is in Aquarius, approaching opposition, and comes to the meridian at 1.20 A. M. in the middle of the month. Neptune is in conjunction with the sun on the 8th, and is hopelessly invisible.

The moon is full at 11 A. M. on the 7th, in her last quarter at 4 P. M. on the 15th, new at 4 P. M. on the 22nd, and in the first quarter at 7 A. M. on the 29th. She is nearest the earth on the 23rd, and furthest away on the 11th. During the month she is in conjunction with Mars on the 2nd, Uranus on the 9th, Neptune on the 21st, Mercury on the 23rd, Saturn on the morning of the 25th, Jupiter and Venus on the same evening within two hours of one another, and finally with Mars a second time on the 30th.

The conjunction of the 25th, when the moon and three of the brightest planets will be within a space of about ten degrees, is a noteworthy one, and recalls a similar event in the winter of 1901.

Rome, May 10, 1922.

Recently Patented Inventions

Brief Descriptions of Newly Invented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

Pertaining to Aeronautics

AIRPLANE WING CONSTRUCTION.—E. V. CROWELL and W. HAWKINS, 1928 E. 7th St., Los Angeles, Calif. The invention relates more particularly to means providing for a change in the wing curve of airplanes at the will, and under the control, of the operator, the device having reference to the cross-section of the wing and the contour of the lower surface. The primary object is to provide in one construction for both extreme lift and extreme speed.

AIRPLANE.—A. A. WELLS, 84 E. High St., Detroit, Mich. The invention has for an object the provision of means whereby an airplane may be readily and simply adapted for flying in a vertical as well as a horizontal direction, means being provided whereby a change in the direction of flight, speed or climbing, may be readily accomplished by a minimum number of controls, and with the greatest degree of safety.

Pertaining to Apparel

LACING DEVICE.—G. W. PAINE, 718 So. Elm, Spokane, Wash. The object of the invention is to provide a lacing device which, when associated with a shoe, will serve to neatly and firmly secure the flaps of the shoe together, and which provides a double expansion so that the flaps of the shoe may be loosened and the shoe put on and removed without the necessity of removing or unthreading the lacing.

INVISIBLE TIE HOLDER.—G. E. and E. L. POTTER, 190 N. State St., Chicago, Ill. An object of the invention is to provide a necktie holder that is adapted to hold a tie of the four-in-hand type in a desired position with respect to the shirt without being visible. A further object is to provide a holder formed in one piece, which can be quickly and easily applied or detached and which has means for preventing accidental displacement.

SHOE-LACE HOLDER.—J. F. LOWE, c/o Health Resort, Oconomowoc, Wis. Among the objects is to provide a shoe-lace holding clip having means for engaging with the top of the upper of a shoe and with the shoe-lace, whereby the looped end portions of the lace are securely maintained in adjusted position relative to the shoe and are not permitted to hang loosely from the knot in the lace or become untied.

TROUSERS CLIP.—E. A. ABOLAN, 9 Word St., Kingston, N. Y. This invention relates to a spring clip to prevent trousers when held by a belt from sagging at the front. The general object is to provide a device adapted to be clipped to a belt and having means to engage a trousers button, clamp, or the like, at the upper end of the fly.

Chemical Processes

PAINT COMPOSITION.—J. F. STEENMEYER, Hull, Iowa. The invention has reference to a paint composition of the class more especially known as "flat" paint, the object is to provide a paint which is durable, washable, and which can be used on woodwork or walls. The composition consists of substantially the following proportions: Zinc oxide 100 parts, linseed oil 47 parts, petroleum 45 parts, banana oil 3 parts and drier 5 parts.

ALLOY.—J. E. SPRINGER, 1 Fair Oak Ave., Hamilton, Baltimore, Md. The foremost object of the invention is to produce a metallic alloy possessing the advantages of lightness, strength, ductility, and a compound which is rust proof, non corrosive and does not deteriorate. The alloy consists of the following ingredients: Copper 20%, nickel 5%, zinc 5%, tungsten 5%, iron 2%, manganese 5%, furnace slag 50%, humite 8%, heating all together to a melting temperature.

BLEACHING LIQUID AND PROCESS OF MANUFACTURING SAME.—P. E. NELSON, c/o Optedahl and Rockne, Roxrud Bldg., Red Wing, Minn. The object of the invention is to provide a simple process of producing a bleaching liquid which may be used with the most delicate linen, which is very mild, has good bleaching and water softening qualities and may be used generally for the home washing. The bleaching liquid is made by adding to water chloride of lime, sodium carbonate, sodium bisulfite and acetic acid.

Electrical Devices

CLEANING AND LUBRICATING DEVICE FOR COMMUTATORS.—L. A. BARRY, Box 670, Kemmerer, Wyo. The invention relates to electrical motors and generators, and more particularly to the commutators thereof, the purpose being to provide a device which serves to constantly lubricate and clean the segments of commutators to prevent excessive wear thereof and to insure a good electrical contact between the brushes and the commutator.

FUSE PLUG.—H. N. DAVIS, c/o Independence Sanitarium, Independence, Mo. An object of the invention is to provide a device which will be exceedingly simple in construction and durable in use. A further object is to provide a fuse plug which may be manufactured and sold at a very low cost, and so constructed that an old fuse may be quickly removed and a new one readily inserted.

Of General Interest

BAG RACK.—G. W. ALLEN, 435 N. Main St., Pocatello, Idaho. The object is to provide a rack adapted for suspending a plurality of different size bags such as are employed by grocers. It is a further object that the bags may be so supported that they are within easy reach for detaching, and that new bags may be quickly positioned, also that means be provided with the rack for supporting a ball of twine for tying the bags.

MILK CAN COVER.—E. AUSEN, R. No. 2, Box 26, Eleva, Wis. Among the objects of the invention is to provide a cover to be used on standard size milk cans, such as are used for shipping milk in quantity, for the purpose of enabling cooling and aerating the milk and cream. A further object is to provide a cover to prevent foreign substances in the air from falling into the can, and in which the aerating means may be locked in open or closed position.

FISHING APPLIANCE.—W. J. LLOYD, c/o Henry Knopp, 117 N. E. 6th St., Miami, Fla. This invention is particularly adapted for use in connection with the catching of larger classes of sea or fresh-water fish or animals, such as sharks, sea lion, alligators, etc., but is primarily intended for the catching of sharks. The object is to provide a device in the form of a float, which will indicate to an observer, at a distance, as to whether anything has been caught upon the hook, or other element associated with the fishing appliance.

NONSLIP DEVICE.—J. G. ZERTUCHE, c/o Ruben Zertuche, Hotel Royal, 535 W. 112th St., New York, N. Y. The invention relates to a device comprising a suction cup which when in use is secured to an article of footwear for men or horses, the cup being sustained inverted in a manner to present its open side to the ground for collapsing under pressure and effecting a holding action to prevent slipping. The general object is to provide a suction cup which insures the quick breaking of the vacuum when the foot starts to lift.

DRAWING INSTRUMENT.—R. D. BECKER, c/o Reid L. Carn, 120 Broadway, New York, N. Y. An object of the invention is to provide means for drawing ovals either with a pen or pencil. Another object is to provide an instrument for guiding a pen or pencil in drawing an oval which may be adjusted to produce any form of oval, and held in its set position while the scribing instrument is guided thereby.

SWIMMING DEVICE.—T. J. CONDON, Sherwin House, Ayer, Mass. The invention relates to an attachment adapted to be applied to each foot of a swimmer. The general object is to provide a device including wings adapted to fold and to spread with the movements of the foot of the swimmer, and having means for comfortably and securely holding the device in position about the ankle and foot.

SINGLE-TREE.—R. S. MATTINGLEY, Rockport, Ind. The object of the invention is to provide a single-tree of such construction that the same will be light and durable and adapted to withstand a great pulling strain without breaking. It is also an object that the structural features shall be adapted to be utilized in the construction of a double-tree or neck-yoke.

FILTERING MATERIAL.—G. W. MATSON, 398 Classon Ave., Brooklyn, N. Y. The general object of the invention is to provide a laminated filtering material which will be highly effective as a filtering medium and at the same time will afford a desirable passage of a fluid therethrough so that a filter equipped with the material will have a comparatively large capacity, the material is made up in sheets to be given any desired form, either flat, curved, or rolled.

CONTAINER AND SUPPORT.—A. WINEBURGH, c/o Carbona Product Co., 302 W. 26th St., New York, N. Y. The invention relates to a container particularly intended for holding a fire extinguishing fluid, the device being so constructed that it may be suspended in any convenient place beside a door or window. An eyelet is screwed into the cork of the container, and a screw extending through the eyelet serves as the support. A pull sufficient to remove the cock will release the contents for immediate use.

FILING DEVICE.—E. G. DAY, 23 Edgewood Road, Bloomfield, N. J. The invention more particularly relates to devices for filing flat papers, such as bills, notes, receipts, and the like, the object being to facilitate the ease and precision with which such papers may be filed and held securely in position. The device further contemplates provision whereby a number of papers may be accumulated together and filed as a unit or filed separately.

PIN.—C. TAYLOR, Newport, R. I. The invention relates to pins especially adapted for supporting curtains, draperies, and the like. An important object is to provide a curtain pin having means whereby the same may be readily and conveniently engaged with a curtain so as to hold the same in position. The device is simple, neat in appearance and inexpensive to manufacture. (See Fig. 1.)

TRAY.—F. VAVRA, 400 E. 91st St., New York, N. Y. The invention has for its primary object to provide means by which shells and similar articles having no commercial value may be utilized. A further object is to provide means by which such articles may be firmly supported with respect to a suitable support, such as a table, wall or the like, the construction being such that the shell may be readily removed.

BOTTLE CLOSURE.—J. W. DUDLEY, 542 Bedford Ave., Brooklyn, N. Y. The invention relates to a construction wherein the closure may be readily applied and removed without injury to itself or the bottle and may be used many times. A further object is to provide a bottle closure having retaining spring hook members and a locking ring adapted to lock the hook members against accidental disengagement. (See Fig. 2.)

COFFEEPOT.—J. E. DUBUISSON, 224 E. Intendenia St., Pensacola, Fla. The invention relates to a coffee-making device which operates in a novel and highly effective manner to produce a beverage of rich strength, flavor and aroma, and in such manner as to completely extract all of the desirable substance in the coffee without converting other substances liable to impair the quality of the beverage. (See Fig. 3.)

PAPER HOLDER.—J. A. F. GRIMBEL DU BOIS, 243 O. Z. Voorburgwal, Amsterdam, Holland. The invention relates more particularly to a paper holder especially adapted to retain sheets of paper in desired position. It may be used as a paper holder for letters, checks, bills, sheets of paper of any kind, for convenient observation, or may be used in banks for holding checks or paper money, which may be placed in the device single handed, and with a single movement leaving the operator with one hand free. (See Fig. 4.)

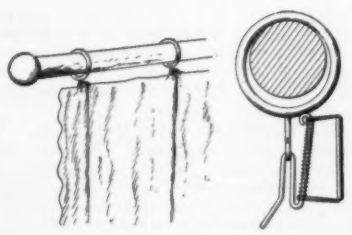


Fig. 1: An improved pin for curtains, etc., invented by C. Taylor

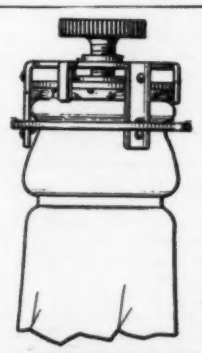


Fig. 2: A bottle closure in a separate unit, patented by J. W. Dudley

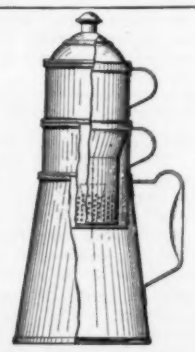


Fig. 3: J. E. Dubuisson's coffee pot of novel design

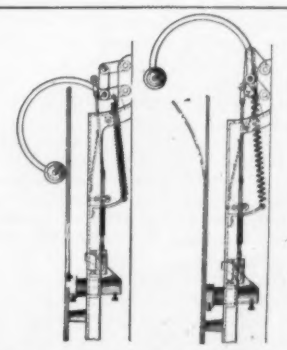


Fig. 4: Paper clip that operates with one hand, the invention of J. A. F. Grimbel du Bois

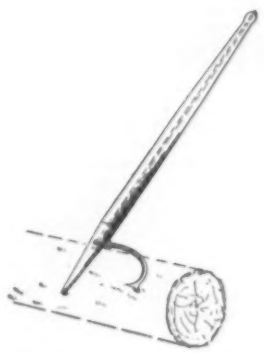


Fig. 5: The non-breakable peavy, designed by D. R. Howe

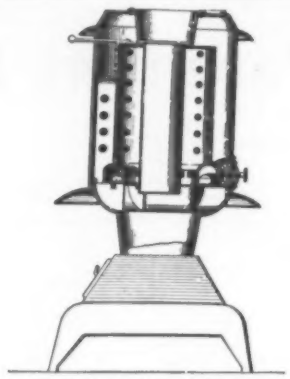


Fig. 6: W. R. Jones heater with improved air feed and heat distribution

Fig. 7: A stop motion for spinning wheels, patented by N. L. Lawton

COLLAPSIBLE METAL CRATE.—J. A. HAZEN, Long Beach, Calif. A purpose of the invention is to provide a metallic crate comprised of separate sections so constructed as to produce a reinforced connection between the sections when they are in set up position and to prevent collapsing and bending of the same under the rough treatment to which it is subjected during shipment.

WATER-COOLING ATTACHMENT FOR ICE-BOXES.—S. KESSLER, 171 E. 107th St., New York, N. Y. An object of the invention is to provide an attachment adapted to be arranged within the ice compartment of an ice-box for maintaining a supply of cold drinking water. The attachment occupies a minimum of space and is so positioned as to obtain a maximum benefit of the cooling properties of the ice. The device is capable of association with practically all ice-boxes of standard type.

INSECT CATCHER AND DESTROYER.—F. PFEIFFER, Sr., 1542 Gates Ave., Brooklyn, N. Y. The principal object of the invention is to produce a device for entangling and holding the insect when it alights thereon, and which is adapted to various uses, and provides a maximum catching surface in a minimum space. A further object resides in the provision of a device which is foldable for shipment into a compact package.

WALL PROTECTOR.—A. G. HALL, c/o Hotel Sparta, Sparta, Wis. An object of the invention is to provide an attachment, for a bed or like article of furniture, which has a bumper or stop member made of a suitable material, such as rubber, and arranged to contact a wall in advance of an article to which the device is applied, whereby such article is prevented from injuring the wall; the device may be easily adjusted without the use of tools.

LEG REST FOR ROCKING CHAIRS.—L. AIME, 306 Kaniygon Ave., West Hoboken, N. J. The invention has for an object to provide a construction wherein a rest is provided which will oscillate or rock in time relationship with the rocker, and which is both foldable and adjustable, whereby it may be adjusted to different sized persons, and when not in use may be folded to a position beneath the chair.

LOCK FOR COLLAPSIBLE EGG-CASE FILLER.—B. ROTTENBERG, 440 Broadway, New York, N. Y. The invention relates to a collapsible cellular filler for egg cases, made up of crossed slitted strips, the crossing strips defining the cells. The device consisting of an element adapted to lie at the top or bottom of the filler and having members adapted to be disposed in cells of the fillers against and parallel with the walls to constitute a brace for resisting collapsing of the filler.

BOX.—J. F. MAURER, c/o New Durham Box & Lumber Co., New Durham, N. J. The object is to provide a box more especially designed to contain milk bottles and the like, and arranged to permit of conveniently carrying the box about. Another object is to provide a box of simple and durable construction, adapted to be shipped in a knock-down condition, and to allow of quickly and securely assembling the parts with the use of but few nails.

SAFETY ENVELOPE.—E. W. OWEN, 515 W. 41st St., New York, N. Y. The invention aims to provide an envelope in which surreptitious tampering with or opening is readily identified. The device comprises an envelope blank, a letter sheet and a plurality of tongues formed integral with the blank and adapted to be rolled one upon the other within the letter sheet when the envelope blank is in closed position.

RING AND SETTING.—R. ROSENTHAL, 15 John St., New York, N. Y. An object of the invention is to provide a construction wherein the usual form of contour of the ring is preserved, and at the same time a readily removable ornament is carried by the ring, and firmly held in place by spring-pressed fasteners positioned in the interior of the ring, while the ornament is arranged exteriorly thereof.

SLEEPING DOLL.—F. REINHARDT, Waltershausen, Germany. The invention has for its object to provide means whereby the eyes of a sleeping doll may be kept open or be reopened in a lying position of the doll. A further object is to provide means whereby the parts for locking or releasing the eyes or lids are automatically actuated in a simple and gentle way by turning the doll from one side to the other.

STRUNG BEADS.—M. WORMSTER, 93 Summit Ave., Summit, N. J. The general object of the invention is to produce a string of beads with a metallic core having a maximum flexibility and strength and to provide for fastening the ends of the core in an effective manner so that the core cannot be accidentally withdrawn from the beads, and at the same time making provision for connecting the ends of the core by the use of a clasp.

BED.—E. CALUSINSKI, 1420 N. Talman Ave., Chicago, Ill. Among the objects of the invention is to provide a bed so constructed as to permit positioning the mattress-supporting means embodied therein in various positions in order that a sick person may be supported thereby to receive proper treatment and that the maximum of comfort may be provided, the operations being accomplished without removing the patient from the bed.

LAMP SHADE.—VIRGINIA W. DARLING, c/o J. A. Darling, Room 3754, Grand Central Terminal, New York, N. Y. The object of this invention is to provide receptacles for various classes of goods, such as candy and confectionery, which receptacles are not only of a highly ornate nature, being of parchment or silk or other expensive material, but which after their initial use, are so constructed that with little trouble they may be converted into ornamental lamp shades for electric bulbs.

UMBRELLA STAND.—J. C. ROMER, 154 Oakland St., Brooklyn, N. Y. The invention has for its object to provide a construction especially adapted for holding umbrellas in theaters and amusement houses. Another object is to provide a stand of simple, strong supporting members, also with suitable braces at the top and bottom whereby the stand may be readily secured to chairs or other objects.

Hardware and Tools

EXTENSION ARM.—J. H. ELLIS, Benedict, Kans. The invention relates to tools used in the constricting of rims to effect their removal from a tire, the purpose being the provision of a tool of this character of simple and inexpensive construction which is extremely efficient and easy to operate and is adjustable to rims of various diameters.

SAW.—W. G. BAKER, 157 Sound View Ave., Classon Point, N. Y. This invention relates to a saw constructed for the purpose of sawing a specially formed type of clothes-pin, whereby the clothes-pin may more resiliently pinch a clothes-line. Another object is to provide a saw in which almost parallel saw members are presented, together with a guiding or gouging trimming member.

FAUCET.—W. E. MADDEN, c/o Bankers' Life Bank, 220 Broadway, New York, N. Y. The invention has for its object the provision of a faucet with a pair of chambers, whereby both filtered and unfiltered liquid may be readily obtained. Another object is the provision of means whereby the filtering device may be quickly assembled or disassembled for cleaning or repair. The device may be inexpensively manufactured.

POWER-DRIVEN SAW.—H. HOLMES, 28 Garden Place, Brooklyn, N. Y. This invention relates to a tree-felling saw, and aims to provide a device of this nature which shall not only be capable of sawing horizontally for felling a tree, but also, after the tree is lying upon the ground, the device may be utilized to saw vertically for cutting the trunk into sections.

GATE LATCH.—C. I. FERRILL, R. R. No. 1, Clinton, Ill. An object of the invention is to provide a gate latch which cannot be accidentally opened when stock bunks or rubs against the gate and latch. A still further object is to provide a latch which will automatically operate when the gate is swung to from either side, and a latch which will be simple and practical, strong and durable in use.

FILING MACHINE.—A. SALATA, 207 E. 15th St., New York, N. Y. The invention has for an object the provision of a simple, compact, readily operable device for filing metallic and wooden surfaces. Further objects reside in the provision of means whereby tools of different character, such as files, saws, etc., can be readily attached or detached, and the machine easily handled and applied.

WRENCH.—B. F. NIGHTLINGER, Sr., 309 New Jersey Ave., S. E., Washington, D. C. The invention has reference to a pipe wrench in which a handle, having a rigid jaw member at one end, is provided with a movable outer jaw member pivotally connected therewith. An object is to provide a pipe wrench in which few parts are used, which is simple, and which permits of use with various sizes of pipes, rods, etc.

PEAVY.—D. R. HOWE, Ashland, Me. An important object of the invention is to provide a tool for handling logs, having a reinforcing rod extending the entire length of the shaft and secured to the head or pick so as to prevent the handle from breaking and also to prevent the accidental disconnection of the handle from the head or peavy. (See Fig. 5.)

CYLINDER POLISHING TOOL.—C. H. SANDFORD, Fayetteville, Ark. An object is to provide a device in which an abrasive agent is maintained in operative contact with the inner wall of a cylindrical member, the device having a rotatable substantially ring-shaped member carrying an abradant on its outer wall and is rotatably supported within a cylinder in constant engagement with the inner wall.

Heating and Lighting

HEATER.—W. R. JONES, Summitville, Ind. The object of the invention is to provide a heater which will efficiently radiate the heat generated by the combustion of solid, liquid or gaseous fuel, which is easily controlled, and which is of simple and durable construction, reliable in operation, and easy and inexpensive to manufacture. Features of the device are the air-feeding and heat-distributing means arranged between the firebox and the casing. (See Fig. 6.)

DEVICE FOR REMOVING CONDENSATE.—H. B. KINGSLEY, 26 N. Main St., Jewett City, Conn. The invention relates to means for removing the water of condensation from the interior of a hollow body which is heated by live steam and is especially designed for use with steam-heated drying cylinders or drums. An object is to provide a device which automatically operates to intermittently remove the water whereby the cylinder will be maintained practically free of condensate and provided for a maximum steam space.

Machines and Mechanical Devices

WELL-DRILLING MACHINERY.—E. B. VERNEUIL, Mangum, Okla. One of the principal objects of this invention is to provide well-drilling machinery which makes it unnecessary to use a rotary, which relieves the drill stem or tubing of torque, which applies the power at the bottom of the well in a highly efficient manner, and which is simple, durable and reliable in operation.

NUT-CRACKING MACHINE.—H. C. ATWOOD, Box 362, Ardmore, Okla. The invention has for its object to provide a rapidly operated machine designed to handle and crack nuts of various sizes. The machine comprises a cracking chamber and a plunger slidable within the same, a feed hopper with discharge means to permit the entrance of the nuts into the chamber, and means to advance the plunger and push the nuts to the cracking point.

DRILL.—O. M. CARTER, 206 Sianlar Bldg., Houston, Texas. The object of the invention is to provide a drill of the expanding-bit type, wherein the bits may be expanded beyond the peripheral surface of the support or contracted within the limits of the same to permit their easy insertion and withdrawal from the drill stem, and wherein mechanism is provided for engaging the bit support which cannot be released until the bit is fully extended.

METHOD OF AND MEANS FOR BLOCKING SADDLES FOR STEAM BOILERS.—R. REES, Smedley St., Kapunda, South Australia, Australia. In particular the invention relates to the use of three specially constructed dies, one top and two bottom ones, fitted with removable and interchangeable blocks, the bottom die being fitted with two hydraulic rams. The saddle is shaped in two operations, in the first of which it is pressed to resemble a pan with outwardly inclined sides, and the latter shaping being completed by the two hydraulic rams.

STOP MOTION FOR SPINNING MACHINES.—N. L. LAWTON, 132 Clinton St., Dover, N. J. The invention relates to textile spinning. Its object is to provide a stop motion for spinning machines arranged to automatically stop the winding-up spool from running in case the yarn breaks. Another object is to stop the rotation of the unwinding spool in case the yarn breaks, to prevent tangling of the loose ends of a broken yarn with the yarns of the adjacent spools. (See Fig. 7.)

DISHWASHING MACHINE.—M. M. UTTERBACK, Chelan, Wash. The invention relates to a machine that is particularly efficient in washing dishes, needs only a limited supply of water, either soapy or clear, is arranged so that the water strikes the dishes directly without missing any portion. The device is simple and can be used as a kitchen table when not in use as a washing machine.

PORTABLE FILM-DRYING DRUM.—H. H. HORTON, 129 W. 48th St., New York, N. Y. The invention has for its object to

provide a construction which may be quickly assembled and disassembled, so that at one time it will act as a rigid structure for supporting a film, and at another may be arranged in a small body for storage or transportation, the entire device fitting into a shallow box which forms part of the structure when assembled.

SEALING DEVICE FOR WELLS.—E. N. MILLER, 135 N. 23rd St., Portland, Oregon. This invention relates to devices for sealing a water, gas or oil well between the wall of the well and the well casing, and the purpose is the provision of a device which permanently seals in a simple and efficient manner the well, to prevent the escape of water, gas or oil during the drilling operation.

COAL POCKET.—H. M. SANKEY, c/o J. L. Tollerton, 265 N. Freedom St., Alliance, Ohio. An object of the invention is to provide a coal pocket having an arrangement of pivoted chute, the latter when in operative position, spaced at its upper end from the wall of the hopper, whereby an entrance is provided for a suitable tool to loosen or break up an arch of coal which might form therein to interfere with the free flow from the pocket.

EARTH BORING APPARATUS.—J. H. HARMAN, 2146 Kane St., Los Angeles, Calif. An important object is to provide a drilling apparatus for oil, artesian or other wells, having means whereby the cutting members may be expeditiously introduced through a drill pipe into the hole being drilled, and having automatic means whereby cutting members are swung to an operative position upon reaching the end of the drill pipe through which they have passed.

APPARATUS FOR LABELING WRAPPING OR THE LIKE.—O. L. STEVENS, 116½ Kirk Ave., S. W., Roanoke, Va. The object of the invention is to provide a machine which automatically applies and secures a label or a wrapping to a can or similar cylindrical article, which is continuous in its operation, and which is simple, compact and durable in construction and reliable in operation. Another object is to provide a machine in which the cement and paste pots are above the line of travel of the cans so as to be easy of access, and free from foreign matter.

BOOM WINCH.—P. J. NIELSEN, 25 South St., New York, N. Y. The invention has for its object to provide mechanism of the character specified, especially adapted for use in connection with ships, for controlling the raising and lowering of a series of booms, and wherein a break is provided in connection with each reel, so that each boom may be independently controlled.

SEED-COOKING APPARATUS.—J. W. STEVENS, 807 Dodds Ave., Chattanooga, Tenn. The invention particularly relates to apparatus for cooking oil-bearing seeds preparatory to extracting the oil therefrom. A purpose is to provide an apparatus which effects a thorough cooking of each and every seed, whereby the oil produced by the subsequent extracting operation greatly exceeds that obtained by apparatus ordinarily used.

TIME POINT INDICATOR WATCH.—P. N. JONES and J. A. EMERY, 115 Broadway, New York, N. Y. The invention relates to indicators and has for an object to provide a time and point indicator for street cars, railways and the like wherein a clock mechanism will indicate not only the time but directly the point or street at which a car should be at any particular time.

FLUID-MEASURING APPARATUS.—S. F. MIOTON, 1528 Jackson Ave., New Orleans, La. One of the foremost objects of the invention is to provide a fluid-measuring and dispensing apparatus which is arranged in such manner that neither a short measure of liquid can be run into the dispensing tank, nor can a short measure be dispensed to the consumer from the tank. Means are provided for automatically closing the inlet valve when a predetermined quantity has been supplied to the tank.

APPARATUS FOR HANDLING LIFE-BOATS.—J. W. WILSON, Room 711, Customs House, New York, N. Y. The principal object of the invention is the provision of an apparatus which permits of the loading of life-boats before the same are projected from the ship's side, and the provision of a common means for lowering both ends of the boat by a single mechanism, and to provide a single apparatus for handling a plurality of boats, and means for cradling the boats when not in use.

ELEVATOR GATE OPERATING DEVICE.—J. E. W. FOGAL, Quincy, Ill. An object is to provide means by which a gate on the end of an elevator car may be raised at will, and when raised, will also raise a hatch gate associated therewith. A further object is to provide gate raising means for electrically operated elevators which will cut off the current to the elevator when the gate is open, and to provide an emergency device, which prevents the dropping of the gate should the cable which raises the gate break.

SHOE POLISHING APPARATUS.—R. V. RICKCORD, 65 W. 192 St., New York, N. Y. The invention relates to power driven shoe polishing apparatus, with brushing elements arranged in pairs, for black or tan shoes, and means for mounting and suspending the brushes from an overhead support to permit of shifting the brushes into just a position to the foot rests, and means adjacent the foot rests for selectively controlling the operation of the brush elements.

DIE PUNCH.—F. J. GARDNER, 2926 So. Blvd., Port Huron, Mich. An object of the invention is to provide a simplified die which may be used with a vise or pressing machine of any kind and which will at one operation form a cup for air pumps and the like. A further object is to provide a die which is formed with co-acting cutting edges and bevel pressing sections whereby when the material is formed in the desired shape, the same will be cut at a correct bevel.

SOOT COLLECTOR.—J. BERNSTEIN, 1914 Cuming St., Omaha, Neb. An object of the invention is to provide a soot collector that is adapted for use in drawing soot from the smoke outlet of a heating apparatus and for conducting the soot to a desired place, as for instance, to a bag or other receptacle. A further object is to provide a machine capable of being moved readily from place to place by motor car.

PRESSURE INDICATOR PROVIDED WITH A SIGNAL DISK.—J. E. MALIVERT, 9 Rue du Telegraphe, Paris, France. The invention has for its object an apparatus adapted to indicate, by means of a signal disk, when the pressure within a reservoir or a piping is maintained below a predetermined value or reaches the latter. The invention consists in a special device for controlling the signal disk so as to ensure a complete protection of the mechanism.

Prime Movers and Their Accessories

INTERNAL COMBUSTION ENGINE.—W. A. SCHAFFER, 197 Main St., Buffalo, N. Y. The invention has for its object to provide an engine wherein one or more pairs of cylinders is provided, one of each pair being a working cylinder and the other a compressing cylinder, and the pistons of each cylinder are connected to a common crank in such manner that the piston of the compressing cylinder will be constrained to move in advance of the piston of the working cylinder at all times, a special form of valve controlling the admission of motive fluid from the compression to the working cylinder.

AIR WASHER.—A. PAJALIC, 593 Continental Ave., Dearborn, Mich. The invention relates to an air washer adapted for use with internal combustion engines, wherein a container for water is provided, and constraining means arranged to permit the air to pass directly into the container above the water to furnish dry atmospheric air to absorb the moisture in the container when the engine is not running. The device may be used in connection with automobiles and the like.

RECIPROCATING ENGINE.—E. SCHMID, Annecy, France. The object of the invention is to provide means for preventing leakage past the hollow spindle of the slide valve of an engine. The apparatus comprises an expansion chamber which surrounds the guide socket of the spindle, and in which working fluid which has leaked into the chamber is stored during compression, expansion and exhaust, and is subsequently restored to the working cylinder during the suction period in that cylinder, through the hollow spindle.

Railways and Their Accessories

LATCH FOR SLIDING DOOR.—E. E. ALLSTATTER, 154 Progress Ave., Hamilton, Ohio. A purpose of the invention is to provide a door latch for the sliding doors of freight cars, which is extremely simple, inexpensive, and durable in construction, and which is applicable to the rear end of a sliding door to prevent surreptitious opening thereof and to lock the door in partial open position. The latch is applicable to doors of wooden or steel cars. (See Fig. 8.)

RUNNING BOARD GUARD RAIL FOR FREIGHT CARS.—L. L. SCHELLINGER, McGraw, N. Y. The invention has for its object to provide mechanism of the character specified for making safe the travel of brakemen and other employees along the running boards at the top of freight cars and to and from the brake wheels. The guard consists of an upper and lower rail, running at about the height of the brake wheel, the device may also be applied to tank cars.

COMPRESSED AIR AND VACUUM RAILWAY.—F. G. TRASK, Ross, N. D. The invention relates to rapid transit railways. An object is to provide means for propelling a vehicle by discharging compressed air against abutments along a track. The propelling means includes the combination of an air pressure and a vacuum system, the former operating to move the vehicle forwardly, the latter to keep certain parts or abutments along the track clean. The rails are lubricated and the power applied direct, the device is designated to insure safety with high speed. (See Fig. 9.)

RAIL JOINT.—J. B. MURRAY, Wilmington, Ill. An object of the invention is to provide a device embodying means for connecting adjacent ends of rails and for resisting the stress placed on the rails by the weight of the rolling stock passing thereover so that sagging of the rails at the joints is prevented, and the necessity for providing the usual fish-plate is obviated. The device comprises only two identical members and means for securing the members to one another and to the rails. The device is adapted for use with ordinary rails.

AUTOMATIC TRACK CONTROL.—F. C. GRAF and M. J. ZWOSTA, 417 Autumn Ave., Brooklyn, N. Y. The invention relates to a system which is operable in conjunction with the signal systems now in use, or may be independently operated by a separate system with equal efficiency. It is one of the specific objects to resort to means operating in conjunction with the air brake system, and to provide an automatic system which entirely eliminates the failure on part of the human element. (See Fig. 10.)

DUMP CAR.—G. H. STEBBINS, c/o Continental Car Co. of America, Louisville, Ky. The invention more particularly relates to dumping mechanism for railroad cars employed for transporting coal, rock, sand and other material, and has for its object to provide an operating mechanism of simple and strong construction, for which the motive force is compressed air under the control of valves located in the engine cab.

RAILWAY MAIL TRANSFER APPARATUS.—C. F. STEGMEIER, Walville, Wash. The object of the invention is to provide a device especially adapted for handling the mail between the railway vehicles and the stations along the railway line, serving to easily and readily effect the transfer of the bags to and from the railway vehicle in one operation and which is especially adapted to be automatically operated, requiring no human control or manipulation. (See Fig. 11.)

Pertaining to Recreation

AMUSEMENT APPARATUS.—F. R. CHESTER, 312 W. 93 St., New York, N. Y. This apparatus is more especially designed for use in pleasure resorts, and is arranged to enable a number of players to participate at a time, and to provide a startling effect at the end of each play. The apparatus includes an inflated balloon, and a piercing member, the balloon and member being movable relatively one to the other, and means for bringing the ballon and piercing member forcibly together.

PUZZLE.—C. H. HAMMOND, 1730 W. 4th St., Wilmington, Del. The object is to provide a simple inexpensive amusement device in the form of a puzzle, including a recessed plate, the base of the plate being of convex form, and provided with a central opening to receive a ball. In use the device with balls on the convex base may be given a circular or shaking motion until one of the balls drops through the opening.

TOY SMOKING DEVICE.—J. C. WILSON, Waynesburg, Pa. The general object of the invention is to provide a device whereby the act of smoking may be simulated, the device embodying a container to receive powdered material and means whereby the powdered material may be ejected in the form of puffs in simulating the puffs of smoke.

TOY.—F. G. DUPELL, 44 Court St., Brooklyn, N. Y. An object is to provide a toy, operated by blowing air therein, the structure being such that the operation will attract the eye, and a signal or alarm will be sounded simultaneously with the movement of certain parts of the device. A further object is to provide a toy to act somewhat similar to carousels but of a size to be carried in the hand.

SPINNING TOP AND SUPPORT THEREFOR.—W. K. MANN, Arkansas City, Kans. The invention has for its object to provide a spinning top and support in the form of a magnet arranged to hold a spinning top suspended without interfering with the revolving of the tops. The magnet is so arranged that two tops while spinning may be supported on the two legs.

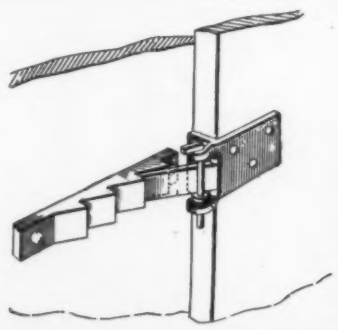


Fig. 8: E. E. Allstatter's latch for sliding doors

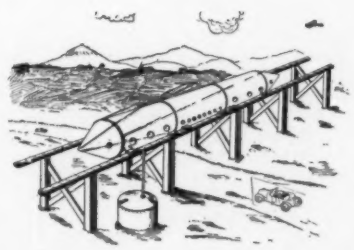


Fig. 9: Compressed-air and vacuum railway, devised by F. G. Trask

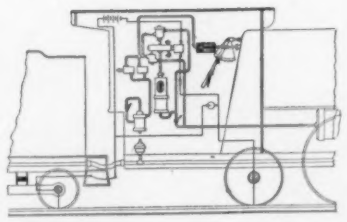


Fig. 10. Automatic track control, invented by F. C. Graf and M. J. Zwosta

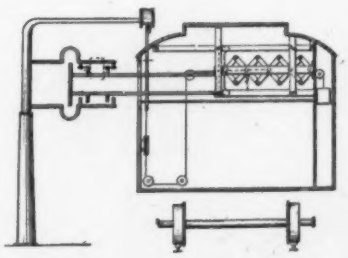


Fig. 11: C. F. Stegmeier's railway mail transfer apparatus

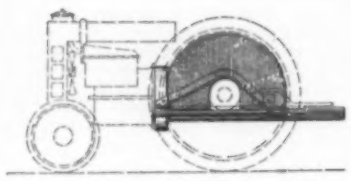


Fig. 12: Safety attachment for tractors, invented by P. O. Trahan

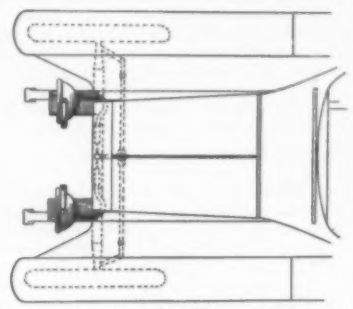


Fig. 13: Directional headlight control, patented by W. Muller

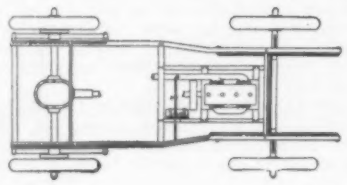


Fig. 14: Motor-vehicle lubricating system, designed by P. H. Gaskins

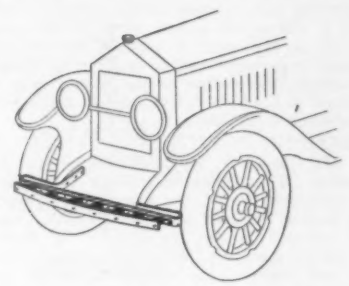


Fig. 15: The bumper into which I. Rosenberg has built a plurality of springs

Pertaining to Vehicles

SAFETY ATTACHMENT FOR TRACTORS.—P. O. TRAHAN, Gueydan, La. An object of the invention is to provide a simple, readily attachable device capable of use without inconvenience in connection with a tractor and which will operate to prevent overturning of the machine, protect the operator from mud, dirt and the like thrown upward by the spokes of the tractor wheels, as well as engagement between the trailing implement and the tractor wheels in making sharp turns. (See Fig. 12.)

SLEIGH.—E. A. HALSETH, Clearbrook, Minn. The object of the invention is to provide a box-sleigh construction so arranged as to be capable of adjustment and which may be instantly converted from a narrow-gage sleigh into a medium or wide-gage sleigh, or, vice versa, the parts being extremely rigid in construction and economical in manufacture.

TIRE-CHANGING DEVICE.—W. L. BUCKSEN, c/o Internal Revenue Agent, Omaha, Neb. Among the objects of the invention is to provide a device for facilitating the changing of tires, and is especially adapted for use with the split rims of the quick-demountable type of tire, wherein means is provided for offsetting the ends of the split rim and for afterward moving said ends longitudinally with respect to each other to collapse the rim.

SHOCK ABSORBER.—F. A. SMITH, 32 Essex Ave., Orange, N. J. An object is the provision of an absorber for automobiles or other vehicles wherein the shocks are cushioned to a greater or less extent without lessening the strength and endurance of the machine. A further object is the arrangement of a pair of hinged plates between the spring and the axle associated with a lever mechanism supported by a spring, the arrangement being such that a slight movement of the plates will produce a magnified movement of the spring.

COLLAPSIBLE HAND TRUCK.—M. E. EMERY and W. J. FLEISCHAUER, 8644 Hamilton Blvd., Apartment 8, Detroit, Mich. The invention relates to a collapsible hand truck designed especially for use in shopping on the cash-and-carry plan, as is largely the custom in buying groceries and small articles. The general object is to provide a truck that may be readily folded into small compass, and when set up would be available for wheeling a child, if not desired for carrying parcels.

WINDOW CLEANER AND WIPER.—H. M. HOWELL, Monroe, La. The object of the invention is to provide a device which is adapted to thoroughly wipe and clean the glass of a window, windshield, locomotive cab or the like, which may be readily operated and requires a minimum degree of effort and attention on the part of the operator. The device is simple, durable and inexpensive to manufacture.

VEHICLE SHOCK ABSORBER.—E. RIMAILHO, 12 Rue de la Rochefoucauld, Paris, France. This invention permits of obtaining the elasticity necessary for deadening the shocks and tremors during the traveling, for example, of an automobile truck on endless tracks with shoes and thus protect the whole of the mechanism while ensuring at the same time the correct contact permanently of the rollers with the shoe. The relative independence of the axes of the felloe and of the hub insures great smoothness of travel over different kinds of ground.

OPERATING MECHANISM FOR TRAILER VEHICLE.—W. L. THOMPSON, Greenville, Miss. An object is to provide operating means for dumping tractor trailers which may be conveniently controlled by the tractor driver from his position in the seat, and which will effect the dumping operation. The tractor supplies the power for discharging or righting-up, and the winding sheave is automatically stopped when the operation is complete.

STORM CURTAIN.—F. L. CANOTT, 752 Glisan St., Portland, Oregon. The invention has for its object to provide a curtain which is particularly adapted for use on automobiles, but which may be applied to other vehicles. A further object is to provide a curtain and a guide therefor which may be readily moved to operative position when the curtain is in use, and can be quickly folded up and swung out of the way when the curtain is not needed.

PORTABLE TRACK.—J. C. BRAIN, 3938 5th St., N. E., Minneapolis, Minn. One of the principal objects of the invention is to provide a portable track which is adapted for use in extricating automobiles, motor vehicles, and similar machines from mud holes, snow banks or the like, and which utilizes the power of the vehicle, to extricate itself when the track is disposed beneath the wheel and provides the required traction to enable the motor to carry itself out of the trouble.

AUTOMOBILE HEADLIGHT CONTROL.—W. MULLER, c/o W. H. Heen, County Attorney, Honolulu, Hawaii. The invention relates to headlights operated by the steering mechanism so that the light will always point in the direction in which the car is moving. An object is to provide means operable from the steering wheel for turning the headlights so that the rays will be directed in a straight path forward of the course of travel of the machine, the device is readily applicable to any ordinary construction of automobile. (See Fig. 13.)

BURGLAR ALARM FOR AUTOMOBILES.—J. L. GETTINGER, 403 W. 49th St., New York, N. Y. An object of the invention is to provide a sounding device and means associated therewith actuated by any wheel of the automobile when the wheel is turned over so as to give an audible signal in case the automobile is moved by an unauthorized person. To accomplish this a removable connecting head is used and placed in position by the owner when leaving the car.

SHOCK ABSORBER.—D. F. MCMAHON, Box 6, Cicero, Ill. A purpose of the invention is to provide a shock absorber of the frictional type where a set of movable plates, is associated with a set of stationary plates, one of the sets being formed with friction surfaces to provide the required friction between the sets of plates to effect a control of the movement of the body of the vehicle with relation to the chassis.

HAND WHEEL.—H. W. DOVER, Hollywood, St. James, Northampton, England. The invention relates to hand wheels such as are employed for steering motor vehicles, for operating stop cocks, controlling aircraft, motor boats, gun mechanism, and other purposes, and has for its object to obviate or reduce the use of cast parts and to cheapen the cost of construction.

RADIATOR GUARD.—C. MICHAELS, Grand Ave., E. Elmhurst, N. Y. Among the objects of the invention is to provide a simple, compact and rugged guard for radiators which is so made that the constant jar or vibration will not cause its parts to work loose and rattle, and so applied that distortion or bending of the guard members is not easily affected by contact.

LUBRICATING SYSTEM.—P. H. GASKINS, 1207 Graham Bldg., Jacksonville, Fla. The invention relates to lubricating systems especially adapted for motor vehicles. The object is to provide a system which insures a proper distribution and application of lubricant to the various elements such as the chassis, springs, steering mechanism, and other mechanism and elements thereof, and is especially adapted to utilize the forces presented by the exhaust of the power plant of the vehicle. (See Fig. 14.)

TIRE CONSTRUCTION.—P. P. GROSSO, c/o U. S. Marine Hospital No. 5, Chicago, Ill. An object of the invention resides in the provision of means whereby the shoe is rendered puncture proof and non-skidding, and by means of which the tread surface of the shoe may be effectively armored not only against puncture but against rapid wear, thereby the life of the tire is greatly enhanced.

TIRE ALARM AND GAUGE.—W. A. HARRIS, Greenville, S. C. The primary object of the invention is to provide a device for attachment to the valve stem of a tire having means to sound an alarm when the pressure drops a predetermined number of pounds, and to repeat the alarm each time the pressure falls, as well as an arrangement having a visible gauge whereby the operator can at a glance determine the pressure remaining in the tire.

VEHICLE BODY SEAT.—V. W. PAGE, 522 5th Ave., Suite 341, New York, N. Y. One of the objects of the invention is to so construct a vehicle seat that the same may be moved from operative position to inoperative position as a single unit. A further object is to so construct the rear seat that it may be swung to inoperative position to provide an unobstructed space between the front and rear seats for storage.

HANDWHEEL.—H. W. DOVER, Holywood, St. James, Northampton, England. The object of this invention is to facilitate the assembly and cheapen the cost of construction of hand wheels, such as are employed for steering motor vehicles, aircraft, motor boats, gun mechanism, stop cocks, and other purposes, wherein the rim portion is built up of annular inner and outer peripheral portions which are encased with suitable material.

TIRE CARRIER.—H. O. SOLLEE, 118 S. Sickel St., Los Angeles, Calif. An important object is to provide a tire carrier for motor vehicles, having simple means whereby the same may be readily and conveniently adjusted for use in supporting tires of various sizes. A further object is to provide a carrier which may be applied to the vehicle while it is being assembled or at any time thereafter without necessitating elaborate alterations in the structure of the vehicle.

DIRECTION SIGNALING APPARATUS FOR MOTOR VEHICLES.—C. C. HEISE, 605 S. Broadway, Decatur, Ill. A purpose of the invention is the provision of a signaling apparatus which includes arrows arranged at the front and rear of the vehicle, having wings which are movable into and out of view, and which indicate when in view the direction in which the vehicle is about to turn or when coming to a full stop, the signals are arranged to be illuminated for night use.

PERMUTATION LOCK.—A. WILLIAMS, Connersville, Ind. This invention has for its object to provide a simple, neat and inexpensive lock of the character specified, capable of use for locking any two parts, one of which fits within the other, and is especially adapted to lock in place on a motor vehicle the radiator cap.

REFLECTOR.—P. E. CORRELL, Verco Bldg., North Terrace, Adelaide, South Australia. The primary object of the invention is to provide a reflector for headlamps of vehicles, whereby the road in front of the vehicle may be efficiently illuminated at night, the illumination being entirely free from "streakiness" or "blinding," which constitute a source of discomfort or danger to drivers of vehicles and pedestrians.

TRACTOR CONTROL.—F. A. MCDANIELS, 1253 Minnesota Ave., Portland, Oregon. Among the objects of the invention is to simplify the operation of steering tractors by persons totally unfamiliar with the structure and without lengthy instruction. A further object is to provide a controlling mechanism which employs a single control lever, shiftable in various directions to effect the driving of the machine forward or rearward, to the right or left, or at various rates of speed.

HEATER.—C. MARTIN, 59 Park Ave., East Orange, N. J. The invention relates to heaters for the cooling system of automotive vehicles, in cold weather. The device is constructed to heat the fluid in the cooling system, and to act as a unit of the system, and will be equally adapted for use in connection with extraneous sources of actuating medium, as well as an actuating medium produced by a unit forming a part of the conventional present-day automotive vehicle.

HEADLIGHT DIMMER.—E. MCPEEK, Sardis, Ohio. An object is to provide a dimmer, which will serve to diminish the blinding rays from a headlight. A further object is to provide a dimmer which accentuates the rays of light which are thrown on the road directly in front of the car. A still further object is to provide a dimmer which may be quickly applied to various forms of headlights now on the market, and which will be simple and inexpensive to manufacture.

VEHICLE DUMPING AND JACKING MEANS.—G. J. SPOHRER, 46 Eppert St., East Orange, N. J. The invention is intended more particularly for use on automobile trucks having dumping bodies, an object being to provide a body raising and lowering means that will be independent of the limitations presented by the chassis and other elements appurtenant to the chassis. A further object is to minimize the dead weight load and maximize the capacity of the truck for freight load.

BUMPER.—I. ROSENBERG, 188 St. Nicholas Ave., New York, N. Y. The invention has for its object to provide a construction which may be used on an automobile or other vehicle and when in use will protect both the vehicle and the object struck. Another object is to provide a bumper wherein a plurality of springs are provided to present a gradual increasing resistance when the bumper strikes an object. The device may be readily applied or removed. (See Fig. 15.)

Designs

DESIGN FOR A DOLL.—E. B. CARD, 94 Fisher Bldg., White Plains, N. Y.

DESIGN FOR TWEEZERS.—S. B. KAHNWEILER, 393 Broadway, New York City.

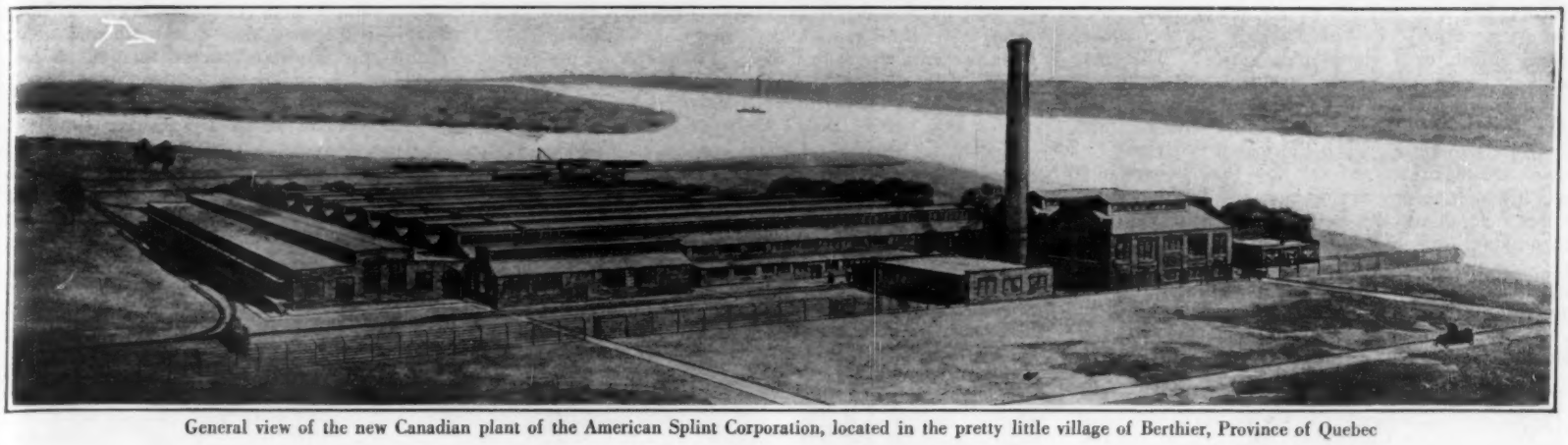
DESIGN FOR A LIGHTING FIXTURE.—I. KRANZ, 55 Christie Street, New York, N. Y. The inventor has been granted five patents for ornamental designs in electric lighting fixtures and lamps.

DESIGN FOR A SIGN.—W. M. CONDON, Harrisburg Hospital, Harrisburg, Pa.

DESIGN FOR A CURTAIN.—J. HEROD, 1115 Broadway, New York, N. Y. This inventor has been granted three patents on ornamental designs for curtains.

DESIGN FOR VENICE LACE.—J. LOOPO, care of Domestic Lace House, Inc., 16 E. 23rd St., New York, N. Y.

DESIGN FOR A FRAME FOR A MIRROR OR SIMILAR ARTICLE.—J. FIRSCHER, deceased, address M. T. Goldsmith, 811 So. 13th St., Newark, N. J.



General view of the new Canadian plant of the American Splint Corporation, located in the pretty little village of Berthier, Province of Quebec

How Much Science in a Common "Parlor" Match?

It Took Plenty, The Chemist and Engineer Found, to Save a Distressed Canadian Industry

By James H. Collins

UP in the pretty little village of Berthier, Province of Quebec, two years ago, a prosperous factory employed more than 400 people, turning out one of the trifles of everyday life—just wooden splints for matches.

Suddenly the world's exchange went topsy-turvy, and with it the trade between Canada and many other countries. This Canadian match splint industry was hit a hard blow. For its product had been sold chiefly to other countries—England, France, Mexico, South America. The cheap money of countries like Poland, Finland and Japan made it impossible for the Canadian factory, paying Canadian wages in stable Canadian money, to sell match splints, in those countries, in competition. There was no prospect of regaining most of the old markets for years to come. And no other adequate market in sight for the 500,000,000 match splints the factory could make daily—half enough to supply both Canada and the United States. So some other product must be found to keep the factory and its workers busy. The management decided, after careful study of the situation and the possibilities, that the logical thing to do was to make complete matches.

Now, when you have begun making a new product, like matches, there are three ways of tackling the job. For one thing, you might lure an experienced superintendent from an established match factory and tell him to go ahead. If you are lucky, he will make for you matches as good as those of your competitors-to-be. But they will be only as good. Another way is to call in scientists, the chemist and engineer, and say: "Study the common everyday match scientifically, find out what an ideal match ought to be, and work out a process for making a better match than the other fellows." And the third, and best way, is to combine the research of the chemist and engineer with the practical "know-how" of the experienced match man—*i.e.*, get all you can out of both theory and practice.

The management of this factory decided upon the latter course, and the very first step, by the way, was facilitated by a Canadian.

About fifteen years ago, the late Robert Kennedy Duncan found a new way in which science and industry could work together—that of the industrial fellowship. Born in Brantford, Ontario, in 1868, Duncan studied physics and chemistry in the University of Toronto, Clark University and Columbia, as well as abroad. Most of his useful life he taught at various institutions in the United States, besides discovering new processes in glass-making, and writing popular books and articles on scientific subjects. The idea of Duncan's industrial fellowships, first worked out at the University of Kansas, and afterward brought to a remarkable development at the University of Pittsburgh, when he became Director of the Mellon Institute of Industrial Research, is as simple as it is practical. A manufacturer who wants more scientific information about making matches, for instance, furnishes money to endow such an industrial fellowship, and one or more competent scientists and research experts are set at work upon his problems. These fellowships, at present fifty in number, have greatly enlarged scientific knowledge in fields as far apart as the factory baking of salt-rising bread, commercial laundering, the utilization of waste citrus fruit and various advances in the steel industry.

Common matches—what can there be for Science to find out about them? Simple splinters of wood, with some chemical stuff on the ends. People use about seven and a half of them daily per capita, so they are made by the billion, and one might suppose that their technology had been worked out long ago. Not so! Match manufacturing is still pretty much a rule-of-thumb industry, supervised by men who have acquired "secrets" or "knack." The first thing Science does in tackling such a job is investigate the scientific literature—and about match-making there was almost no such literature.

Interior view of a typical small research laboratory at the Mellon Institute, Pittsburgh. It is here that the problem of match manufacture has been worked out scientifically

To the research chemist, a match is very far from being simple or commonplace. In fact, he doesn't regard it as a match at all, but thinks of it as a high explosive bomb! For modern match head compounds are truly high explosives, capable of doing as much damage as TNT in the quantities and under the conditions used in munitions. As matches, of course, they are harmless, even by the box or case. The match-bomb has its "detonator" and its "time fuse" to set it off, while its stick is the element upon which they act, comparable to the main charge of a shell or hand grenade. Moreover, it must be a bomb with a timed explosion, neither too fast nor too slow. And on top of that it must go off with the least trouble on the part of the person who lights it, yet not go off accidentally.

The first step in making matches is cutting the splints—we will begin there.

Edward E. Marbaker, Ph.D., was given the Phosphorus Fellowship at the Mellon Institute founded by the Canadian match splint corporation, and went to work in October, 1921, working with and under the direction of A. W. Lissauer, Chem.E., a New York consulting engineer, but aided and supervised by the executive staff of the Mellon Institute.

Match splints the world over are made from various kinds of wood, but most of the matches used in North America have pine sticks, while European match splints are chiefly aspen. Pine is more costly because it is a wood much in demand, fit for many other products, while aspen, used in hardly any other ways, is cheaper—and its use for matches conserves other lumber. The importance of this consideration, together with the value of the development of a latent resource, in the economic advance of Canada, was not overlooked in the selection of aspen as the raw material. Match splints are also, either round or square, pine being most easily cut in the round shape, and aspen in the square.

This Canadian factory had been turning out square aspen splints for its European customers—

Europe has accepted the square match these many centuries. Should its "ideal match" have a square aspen splint, or a round pine splint? That may not look like an engineering problem, and yet it was. For a match splint is as much an engineering structure as a bridge chord. It must be strong enough to resist splintering when the match is struck. Its shape should afford an easy flow for the paraffin in which match splints are dipped, and for the flame's travel. It should be long enough to burn for a reasonable time without burning the fingers. It must be partly fireproofed, so its charred end will not break off, and to prevent afterglow in the stick and head, and relighting when the flame is blown out. Then, it must be reasonably smooth, and easily struck without getting splinters into one's fingers, and finally, as near white as possible, for good looks.

Apart from these requirements, match splints are simple enough!

After engineering and chemical experiments, a square splint of aspen was chosen. Aspen is a stronger wood than white pine, and burns with a steadier, more uniform flame, and the square splint is stronger because it contains more wood. It is easier to grasp, and keep from turning in the fingers. A square splint has more edges along which flame can travel than a round splint—a split stick in the fireplace burns better than a round log. The wood is not compressed in cutting square splints, and so it takes up impregnating chemicals better. And a square splint holds a match head better because its larger end and four sides give more clinging surface.

Pine for match splints is usually dried by stacking outdoors anywhere from one to three years—drying it artificially is too expensive. But carrying such a vast stock of raw material is costly business, too. The air conditioning engineer stepped in here to speed up that detail in the new Canadian match factory. With the more easily dried aspen, and with the improved methods of handling, it was found possible to turn a green log into dry splints ready for the heads in about two hours—and into matches in another hour. First the bark is removed. Then the veneering machine pares off a continuous sheet of wood the thickness of a match, round and round the log. This veneer sheet is cut into strips, and the strips chopped into individual match splints, which go through tanks of the impregnating solution and are dried in rotary dryers by steam. The entire splint and match process is continuous and almost automatic, employing, practically throughout, specially designed machines. All available machines on the market were studied and dissected to determine and overcome all defects. From this study were evolved new machines for practically every process, combining the necessarily tremendous production of a new perfection of product, with an almost "foolproof" construction. The choppers for splints, for instance, each have a capacity of about eighteen hundred pieces per second; the match dipping machines each turn out about five hundred perfectly finished matches in the same period! Surely this is a great advance in the art.

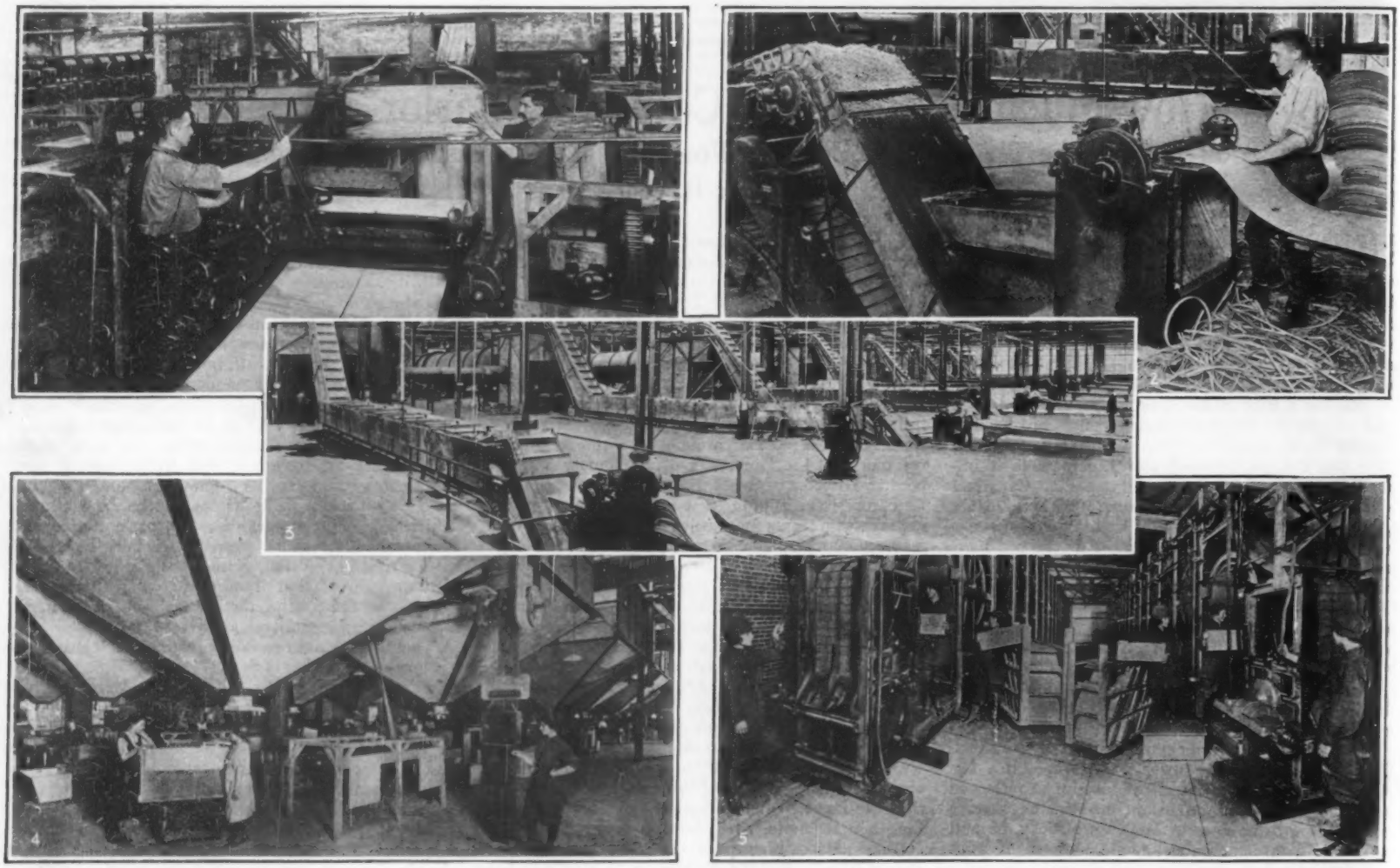
Conveyors carry the wood in process from one station to another past inspectors who check the color and quality continuously. The long rows of veneer lathes are in an unbroken line across the vast width of the building. Ingenious sheet choppers cut the sheets into exact lengths and widths with revolving knives whose tremendous speed fill the plant with the noise of a dozen ocean liner sirens. The tremendous rotary dryers each are eight feet in diameter by sixty feet long; all give the visitor a glimpse of enormous quantity production by the harnessing of great forces.

Even more complicated and interesting is the head of a match—in this case the "double-tip-strike-anywhere" kind—the familiar "parlor" match. It has a large, colored head known as the "inert base," meaning that it will not light without the fine tip of ignition compound which acts as the "time" or "contact" fuse.

The match head must burn with the least amount of smoke and odor. It must be fairly windproof, burning in an air current of reasonable force, or lighting up again when sheltered if the flame has been blown down. It must be waterproof, so that matches actually can be dipped in water and not spoiled. It must be sure fire, giving a full flame, not be noisy in lighting, nor flash up too quickly, burning one's fingers. The head must stick securely to the splint, not only before the match is used, but afterward, and it must not break nor split either before or after.

The inert base must be oval or pear-shaped, so when matches are packed or carried in the pocket, the white tips cannot come in contact with each other or with the inert base, accidentally setting themselves off. The tip must ignite easily by light friction on the smooth surfaces where people usually scratch matches—paper, wood, leather, cloth. It must make the slightest possible mark, not scratch or tear such surfaces, and the inert base must not stain either the wood or the splint, the clothing or the hands.

Then, people like color even in match heads—any color at all as long as it is a cheerful red! So a pleasing color is part of the ideal match, and dyes are one of the many chemicals used in match compounds. One gets an idea of the field for chemical research in match heads when it is known that among other things they may contain phosphorus sesquisulphide, red phosphorus, potassium chlorate, ferric oxide, zinc oxide, ground glass, glue, rosin, carbon,

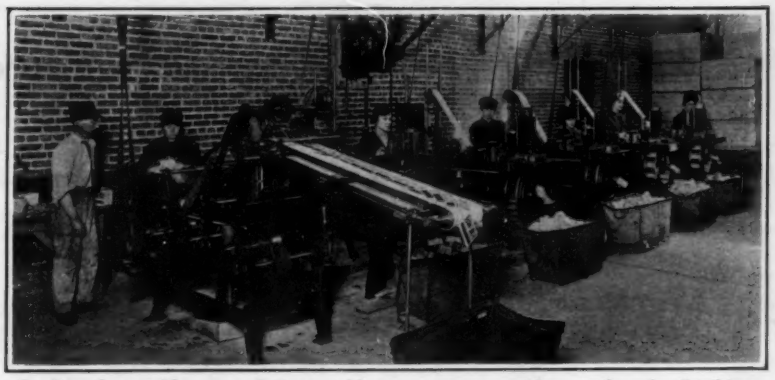


SOME OF THE MORE INTERESTING PHASES OF CONVERTING LOGS INTO MATCHES

1. Cutting big logs into thin sheets of wood known as veneer. 2. Making splints out of the sheets of veneer. The veneer is fed into the machine at the right, and the splints are removed from the machine at the left. 3. General view of the machines which convert the sheets of veneer into splints, and the tanks in which the splints are impregnated and the ovens in which they are dried. 4. Huge bins in which the splints are stored and from which they go on to the dipping machines. 5. The loading end of two of the enormous match dipping machines

casein, asbestos powder, plaster of Paris, formaldehyde, pumice, lead thiosulphate, charcoal powder, silica, kieselguhr, aniline dyes—and so forth!

Many chemical combinations were made and tested to secure the highest attainable quality of match head. Most of the research was along original truly chemical engineering lines, each step being predicted by calculation and then proved by numberless chemical tests and laboratory production. It is one thing to make an "ideal match" in a laboratory, but turning them out in the factory by the hundred million daily is a very different thing. A process had to be invented as well as a match.



Sanding the outside cover of the matchboxes so as to provide a surface for "striking a light"

This Canadian match splint factory, almost idle a year ago, is not only running again, but now employs more people than ever. High quality and uniformity of product are obtained through test-control during the whole process, and air conditioning, or control of the climate inside the factory.

After the splints have been cut, impregnated and dried, they are carried automatically to tables which jog out all the broken and imperfect ones. Then other jogging machines level them up in parallel rows ready to be fed to the dipping machines. These machines each have a capacity of 2,000,000 matches per hour. The dipping machine has a framework carrying a long chain made up entirely of perforated plates, into which the splints are automatically fed two rows at a time, and begin the long journey that transforms them into matches. First, the splint ends pass over a hot plate, and are dipped in a bath of melted paraffin. Then they are dipped in the inert base compound, travel along on the chain until partially dry, are dipped again for the tiny ignition tip, and finally, when the trip is finished, and the drying completed, the finished matches are automatically discharged, row by row. The entire journey around the machine takes an hour.

Logs—the raw material from which the splints for the matches are made

These different compounds of chemicals must be kept within very narrow limits of viscosity, so that each splint will get a head of uniform size and shape, and dry in the allotted time. The process must be carried on in uniform temperature and humidity.

"Pick out the ideal day for making matches," said the air conditioning engineer, "and I will reproduce it for you 365 days in the year."

Not many years ago, match factories were usually compelled to close down or greatly curtail production during the summer. With apparatus for cooling and drying the atmosphere in the dipping room, it is here kept uniform practically without variation.

In this plant by air conditioning, also, another handicap of the match manufacturer in the winter has been overcome—spontaneous combustion. Static electricity, or even stray air currents passing over certain parts of the huge dipping machine, would light up matches in those places. This trouble is abolished by air conditioning.

A noisy "banger" match that makes you jump when you strike it is really one that has been case-hardened by too fast drying. Its hard shell makes a miniature grenade, and when the head is ignited it goes off with a real explosion. With perfect control of climate in the dipping room, these "bangers" are eliminated by regulating temperature and humidity.

The whole process in this Canadian plant is controlled by tests from log to packing room. Everywhere along the line samples of splints and matches are constantly being taken out and put through testing machines. The splints are tested for strength, uniformity in size and whiteness. The base and tip compounds are given a viscosimeter test. They must be something like thick syrup. If either too thin or too thick, the matches will not take good heads in dipping. The viscosimeter indicates this syrupy quality of a compound in degrees as accurately as a thermometer indicates temperature. The sensitiveness of matches is tested, too, by putting them into a machine that rubs their heads with an alundum surface at a certain speed and pressure, and sensitiveness can be measured by the quickness, force and percentage of ignition.

Making the trays for the matchboxes. These machines convert rolls of cardboard into boxes

Even the boxes in which the public buys the matches are made by machinery that folds the paper, prints on the label and turns one side of the box into a sandpaper striking place, and the matches themselves are put into the box by machinery.

The chemist and engineer find so many points of quality in the common "parlor" match, and so many details to watch and keep up to standard that they suggest a standard by which the consumer might see that he gets his money's worth in matches.

One is quality, which can be determined by taking a handful of matches from the box, holding them upright and examining the heads. If they are good matches, from the consumer standpoint, each head will show its ignition tip. If that tip is missing, the match is imperfect, because it will not light when struck. Five to ten per cent of a boxful of inferior matches may be tipless, and many have no heads at all, plainly showing careless manufacture or inspection.

Another consumer test is count. Who bothers to count anything as cheap as matches, forty or fifty for a penny? Not the public nor the grocerymen, maybe, but counting matches one by one, hundreds of boxes of them, was part of the work in establishing this new plant and process in Quebec. Every box of matches bears a number indicating the count—200, 400, 500, and so on, as the case may be. In Canada a revenue tax is paid on matches by count. Actual counting of matches bought in retail stores showed many boxes short twenty-five to fifty matches—not so much an indication of dishonesty, perhaps, as careless packing. On that account the Berthier plant has been equipped with automatic means for putting a full count of perfect matches in every box.

"A few centuries ago," says an English author, "if you had produced a little piece of wood, and by rubbing it lightly on a little box had caused the end to ignite suddenly, you might have run some risk of being yourself set on fire as a professor of the Black Art. If, however, you could have persuaded people to view the matter differently, and you had possessed a few dozen gross of boxes, a large fortune would have been at your command.

"Today, the man is poor indeed who cannot afford a box of the useful little sticks that are among the cheapest of the cheap things that we buy. For matches to be so cheap, their manufacture must be conducted very economically. You cannot imagine even a Chinese workman being able to split and dip separate matches and sell them profitably at present prices. He could not possibly compete with the machine of the white man who strews matches so plentifully wherever he goes."

Science Notes

A Digest of Everything of General Interest Appearing in Current Literature

Leprosy in Colombia.—A German leprologist is to study this disease in Colombia, decide on the necessary sanitary precautions, examine victims and suspects, and plan arrangements for isolation.

Nicotine and the Human Psyche.—In the non-habituated, one-half milligram of the pure base will produce noticeable effects; heavy smokers tolerate doses up to 8 milligrams without marked reaction. The effect of tobacco is not pharmacologic but psychic, owing to taste, odor, and visual sensations.

A Tiny Product.—Consul Winans at Prague reports that radium production in Czecho-Slovakia is reviving. The record of her radium mines is: 1911, .7746 gram; 1912, 1.6977 grams; 1913, 2.0074 grams; 1914, .8751 gram; 1915, 1.7118 grams; 1916, 1.4013 grams; 1917, 2.7749 grams; 1918, .0459 gram; 1919, .9689 gram; and 1920, 2.2310 grams.

Hospital Transported Pick-a-Back.—Dr. A. L. Piper, who for five years has conducted a grass hut hospital among the Alunda tribes of Africa, recently bought a large stock of medicines, test tubes and laboratory equipment in America. These must be conveyed on the backs of natives for 17 days, under a scorching sun, before reaching their destination.

A King Among Cactuses.—Columbia University has received from Dr. H. H. Rusby, now exploring the Bolivian jungles, the photograph of a cactus with a limb spread of 40 feet; it is probably the largest true cactus in the world. The Bopi River region has yielded many interesting specimens, among them the "tree of life" used by the natives for medicinal purposes.

Equinoctial Storms.—Belief in the "line storm" is deep-rooted; for superficial observation—which is all that most of us achieve—annually supports it. Since, east of the Mississippi, rain falls two days in five throughout September, it would be strange indeed if we got none either on the 20th, 21st, or 22nd; and this is sufficient to perpetuate the equinoctial theory in the popular mind.

White Pine Blister Rust.—White pine is again threatened by the blister rust; some New York and New England stands are 46 per cent infected. This rust can spread from tree to tree only through the medium of currant or gooseberry bushes. Movements have been organized to eradicate these bushes over a radius of 300 yards from the trees; both wild and cultivated bushes must go if the stands are to be saved.

Frozen Eggs and Food Poisoning.—In France many cases of poisoning during the intense heat of last summer were traced to frozen eggs from China that were used in bread and confectionery. Before shipping, the opened eggs are frozen in cans at —15 degrees C. If these are allowed to thaw long before using, mold, streptococci, staphylococci and *B. coli* will be found. Only in biscuit making is the use of these frozen eggs safe; here the prolonged high temperature destroys the bacilli.

Novel Economics.—Press reports say that high officials in Washington credit the boll-weevil with the up-turn toward prosperity in business, since the threat of a lean cotton crop sent cotton prices aloft and started a general rally. If this is sound economics we should coddle our farm pests, not fight them. Evidently, whatever tends to decrease production, whether insects, or the elements, or striking workers, should carry us toward prosperity. We have much to learn and to unlearn.

The Great "Mummy-Wheat" Trick.—The fakers and jokers who "salt" Egyptian tombs with wheat grains for the amazement of the credulous tourist, who plants these "thousand-year-old" seeds and sees them germinate, sometimes overreach themselves; one of them used maize instead of wheat; as maize was introduced into the Old World from America, the trick was apparent. Numerous experiments with wheat seeds of authentic antiquity, conducted by such Egyptologists as Unger, show that their vitality is lost in a few years. Certain seeds, if well-guarded from moisture, are alive after ten years; even after twenty years the protoplasm of a few may retain the power of augmenting its volume by absorption of moisture, and may develop definite form, but is soon disintegrated by the influx of air and water. Germination becomes impossible in from 20 to 30 years.

Prehistoric Corn.—W. E. Meyer, of the Bureau of American Ethnology, has found in Davidson County, Tennessee, stone-slab graves holding mortuary vessels filled with corn. The variety is that of many-rowed tropical flint, about half-way between true flint and popcorn. This corn was undoubtedly grown in prehistoric times. The same kind is found in the West Indies today, and beyond question there must have been, in those far-off days, communication between the West Indies and North America.

Anthrax and the Shaving Brush.—Anthrax, the splenic fever of cattle, is occasionally conveyed to human beings through contact with infected wool, hair or hides. In 1919 forty-six lives were lost in the United States from this cause in the greater number of cases infection was traced to the shaving brush. The bacillus, itself easily destroyed, is spore-bearing, and the spores may be active in the brush for a long time. Infection is easily avoided by the simple precaution of sterilizing a new brush, but this should be done in a thorough, professional way.

A Great Metallurgist Dies.—Metallurgy suffered a severe loss in the recent death of Professor Henry Marion Howe who did so much to develop the metallurgy of steel, particularly by his classic work entitled "The Metallurgy of Steel," which appeared in 1891. He played a leading part in the development of manganese steel in the United States. He came of a famous family, his father, Dr. Samuel Gridley Howe, did much to further the cause of Greek independence and his mother was Julia Ward Howe the famous author of the "Battle Hymn of the Republic." All Professor Howe's sisters are well-known authors so it helps to prove that genius often runs in families.

Aerial Murders Over New York.—In old times falconry was a royal sport, and hawks were trained to lay their kills at their masters' feet; today, in India, deer are hunted in this way. During our winter months the ghastly remains of valuable homing pigeons are frequently found on the roofs of New York, and the pigeon hawk and sparrow hawk have been accused of these murders. Dr. Chapman, of the Museum of Natural History, finds the guilty raider to be the "noble peregrine" of history, known to us as the duck hawk; this robber-baron of the air winters in the clefts of the Palisades; it is so swift that even teal, winged bullets as they are, cannot escape it, and to this quality it adds amazing strength and courage. Sportsmen are just now reviving falconry in this country.

The Spectrum of Fluorine.—The method of preparation of fluorine gas by electrolysis of fused potassium acid fluoride due to Mather and others of the Chemical Warfare Service is described by William R. Smythe in the *Astro-Physical Journal*, together with the necessary apparatus. The gas was purified by passing through sodium fluoride and a freezing trap. To protect the pump a charcoal trap was inserted. A dozen previous researches had failed to determine definitely the lines due to fluorine because of impurities in the gas used. In this research a spectrum with foreign lines absent or very weak was obtained by flowing practically pure fluorine gas at atmospheric pressure continuously through a discharge tube with gold electrodes. Although the tube had a fluorite window, put on in optical contact without cement yet practically airtight, and both a quartz spectrograph and a 50 cm. concave grating were used, the only fluorine lines found were ten between λ 6239 and λ 7034. The wave-lengths of these lines, determined to about 0.1 A, are given and also the approximate positions of the heads of nine bands presumably due to CF_2 between λ 4829 and λ 6525.

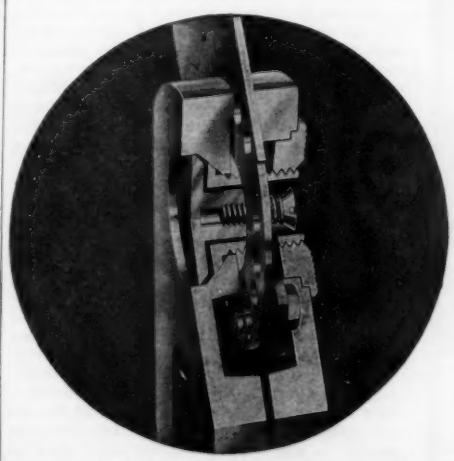
Mechanical Engineering Notes

Plastic Wood is the name given to a new material manufactured by a British concern, namely, a collodion preparation made with very fine wood meal, and as supplied ready for use of the consistency of soft putty. This material will probably be of most interest in connection with patternmaking and molding, for it can be used for ordinary filling and stopping work in wood patterns and for fillets. It adheres firmly to wood and can be applied and smoothed down by the thumb or a tool. It is claimed to be waterproof, to set quite hard, and can be cut with an ordinary tool like wood and turned in the lathe. It can also be finished with sandpaper. It shrinks slightly in drying, but the hardened material is not brittle and nails can be driven firmly into it without cracking it. A solvent is also available to soften the material, according to a writer in a recent issue of *Engineering*.

Lubrication of Machine Tools.—The lubrication of machine tools is largely done by hand. Experience has shown that bearings lubricated in this way are often neglected. It is essential that careful attention be given to a regular routine of oiling the tools, in order to prolong their life and minimize the frictional losses, which, in the case of light and medium high-speed machine tools, may amount to as much as 50 per cent of the full shop load. Care should be taken to see that all oil holes are protected from entrance of dust by covers. It is the practice in some cases to place felt pads in the oil passages leading into the bearings, in order to receive the oil during each oiling, and afterward gradually allow the oil to pass into the bearing surfaces, so that the lubrication becomes more regular, and therefore more efficient, than would be the case if the oil was fed direct to the bearing by hand oiling without the felt pads, states the *Practical Engineer* in one of its recent issues.

Colloidal Theory of Rust.—Dr. Newton Friend, in a lecture before the Birmingham Metallurgical Society on Recent Progress in the Study of Corrosion, states that after examining various theories to account for the phenomena attendant upon corrosion, he directed his attention to the "colloidal theory" which had been formulated by himself, and which, he said, reasonably accounted for the facts. If moving water was increased to a velocity of eight miles per hour, no corrosion of immersed metal took place. According to the colloidal theory, corrosion of iron in a neutral solution of water was entirely distinct from corrosion in acid. Iron first passed into solution through the presence of electrolytes, gradually developing a solution of ferrous hydroxide, which eventually produced oxidation. The solution, however, could be removed by rapidly flowing water, thus inhibiting corrosion. The same retardation could be effected if the colloid was coagulated either by physical or chemical precipitants.

Reproducing Cast Iron Patterns.—It not infrequently happens in repair work that some cast iron part is required exactly to the size of the old one, and in this there is considerable difficulty if the piece is of any size, because in that case the molder can not rap out the old part sufficiently to allow for contraction. Obviously, the correct method would be to prepare an accurately dimensioned drawing of what is wanted and send this to the patternmaker, or, failing this, to send him the old part with any necessary notes as to what has to be added, he then making a proper pattern for the molder's use. This costs money, and often more than the job will really carry, for which reason in many cases the help of a skilled jobbing molder can be successfully invoked, because by breaking up the replaceable part it is often possible to get in contraction allowances. The matter wants skilful handling to get the size additions into places where they do not affect the ultimate result, while, in addition, very careful molding is necessary when working from a broken-up casting. Some things can not be made without proper patterns owing to their shape, and if the previous casting has been made from an old one, usually without a new pattern, a general mess of the job will result. Cast metals contract all ways at the same rate and not in length only, and this makes it a matter of some difficulty to obtain a replica from an existing casting, while the difficulty is increased where the old casting has been machined. In taking in repair jobs this particular point should be noted, because the cost of a pattern adds a big lump to the cost of one casting.



Section of the head of Simore Universal Square, showing sturdy mechanism which insures permanent accuracy.

Positive Adjustments of Simore Square are Rigid and Accurate

The many advantages of the SIMORE AUTOMATIC would be of little avail unless the tool were thoroughly accurate and so designed as to insure permanent precision and to render it able to stand up under the exacting conditions of every-day use. The construction is made clear in the illustration where the mechanism is plainly shown.

As will be seen, the blade is provided with a series of holes disposed on a wide circle around the pivotal axis. The heavy sheet steel spring carries at its upper end two small tapered, hardened studs, spaced wide apart and rigidly held by nuts. When the blade is locked at a positive adjustment, these two studs are engaged in one of the five sets of holes, the slightly tapered points being continually forced into the holes under pressure from the spring. At the same time the blade is supported on the heavy and extremely rigid central bearing so that it is firmly held at these points.

The Wear on Mechanism Automatically Taken Up

This construction, together with the fact that the blade is made of tempered steel and that the surface of the studs is as hard as glass, reduces the wear to a negligible quantity and causes any such slight wear as should occur to be automatically compensated for. It also insures the permanent accuracy of the tool, since the centers of the holes, upon which the adjustments depend, always remain exactly true.

Civil Engineering Notes

The Oil Shale Industry.—Notes recently issued by the Bureau of Mines, preliminary to a full bulletin, discuss the history of the industry and its status in the United States and Scotland, and compare American and Scottish methods of assaying.

"Smokers" for Women now make their appearance on British trains. Woman have been crowding the men's compartments to an uncomfortable degree—not, officials say, because they want to ride with the men, but because they insist on smoking while traveling.

Harnessing the Volcano.—It is proposed to make extensive drillings into the great active volcano of Kilauea (Hawaii) in an endeavor to determine the heat of the volcano, the quantity of steam underneath, the mineral constituents, and the solution of other relative questions. Borings are to be undertaken at the sulphur banks, at several places in the bottom of the crater, and in the region of recent lava flows at Kau Desert. It is intended to penetrate the surface where the lava flows are of known date, so as to learn what changes of temperature underground have taken place with the passage of time.

New Device Tests Road Smoothness.—A traveler passing along a highway and seeing this apparatus might think it the latest development in touring machines, and sympathize with the fellow supplying the motive power. He would be entirely mistaken though for it is an apparatus devised by engineers of the Bureau of Public Roads of the United States Department of Agriculture and used on a road test in cooperation with the Illinois State highway department. Its purpose is to measure roughness and unevenness in a road surface before and after traffic tests, which it does with an accuracy of a small fraction of an inch.

The Cause of Instability in Invar Steel has recently been discovered by M. Guillaume, who has also found a means of practically eliminating it. This is achieved by the addition of a small proportion of chromium, the result being that the extent of the instability, as measured by the change in length after 100 hours at a temperature of 100 deg. Cent., is reduced to one-tenth of its former value, while its low coefficient of expansion remains unchanged. A further addition of chromium will entirely eliminate instability, but results in a higher dilatability. This new alloy is susceptible to the thermal and mechanical treatments which are made use of to reduce the expansion or ordinary Invar steel, but, continues *The Engineer*, their effect is less pronounced in its case.

Port of London Improvements.—In conjunction with and in extension of its original scheme of improvements at Tilbury, the Port of London Authority is now seeking parliamentary powers for the execution of additional works involving an expenditure of nearly £1,000,000 and having for their object the provision of increased passenger traffic facilities at the port. Included in the proposed new works are the construction of a floating landing stage connected to the shore by two main bridges, the provision of conveyors for handling luggage, and the erection of a new baggage hall. By means of these improvements the transference of passengers from the liners to the shore and their transportation to London would be considerably expedited.

Thawing Sheds for Coal Cars.—The unloading of coal and ore from railroad cars in winter is often hampered by the freezing of the contents into practically a solid mass. In order to provide against delays of this kind at the South Amboy coal terminus of the Pennsylvania Railroad, upon which a number of large public utilities are dependent for their coal supply, two large thawing sheds have been constructed. Each of them is a concrete structure 45 feet long, having two lines of rails, each accommodating ten large cars or coal wagons. When the twenty wagons have been shunted into the shed, the doors are closed, and blowers force a current of air over steam radiators and thence through ducts beneath the floor, from which there are outlets 6 feet apart beneath the cars. The air, heated to 200 or 250 degrees Fahrenheit, soon begins to thaw the frozen mass. The thawing process can be accomplished in from one to twelve hours, according to the extent of freezing, but the average time is about three hours. From each shed the cars move by gravity to the two dumping machines, which raise and tilt the wagons so as to discharge the coal into barges for delivery at various points on New York harbor.

Electrical Notes

Safety Switch Congress.—More than 700 executives and safety, electrical and mechanical engineers recently attended the first safety switch congress held in America. Thirteen switch manufacturers exhibited various types and sizes of safety switches, and electrical engineers and superintendents had an opportunity to offer suggestions to the designers. Tentative arrangements are being made to hold a congress and give the exhibit in various cities.

An Armature Rewinder.—There has appeared on the market a simple device for rewinding small armatures, which is certain to lighten work of this kind to a marked extent, yet which represents but a very small investment, as compared with the elaborate winding machines now in such general use. The little winder consists of little more than an adjustable holder which holds the shaft of the armature, a crank for turning the armature end over end, and a turn counter. The device can be mounted on any bench.

Electrification in Russia.—In a recent issue of *Elektrotechnische Zeitschrift* there appears an account of what is being done and planned regarding electrification of Russia. The undeveloped water powers o Russia are estimated at 20,000,000 horsepower. For the first step of a general electrification there should be required 1,100,000 kilowatts in turbo-generators, 640,000 kilo watts in water turbines, 131,000 tons of steel 41,000 tons of copper (exclusive of ma chines), 150,000,000 bricks and 6,000,000 barrels of cement. The cost of this first step is estimated to be 833,000,000 gold rubles. Almost all the material would have to be imported.

Prevention of Low-voltage Shocks.—The way to prevent low-voltage accidents, states Mr. Whiting in his paper, "Lessons Learned from Forty Electrical Fatalities," lies in enclosing all current-carrying elements to a height of 7 feet at least above the floor, boxing in all fuse cut-outs, getting rid of bare motor terminals by boxing in or through insulation, replacing old knife switches by enclosed switches, keeping open wiring out of reach, avoiding the use of drop cords and using safe types of lamp sockets. If extension cords are necessary, the highest grade of reinforced cord with the lamps mounted on wooden handles with porcelain sockets and lamp cages should be employed. In addition, all dead-metal parts of low-tension equipment should be permanently grounded.

An Armature Business of Large Proportions has been established in Chicago, which, because of its exceptionally efficient operation, is certainly unique. This business concern repairs and rewinds armatures for all kinds of small generators and motors, and maintains a complete armature service for all generators and motors up to one horsepower. Over 5000 armatures are kept in stock. Thus to cut down the length of time during which a generator or motor may be out of commission while the armature is being repaired, this concern ships a duplicate armature and, in due course, repairs the damaged armature which is then put in stock. Each workman engaged by this concern is a specialist. He performs only one operation. He is a stripper, a winder, a solderer, a varnisher, or a tester. He is paid on a profit-sharing basis and is closely checked up and held responsible for every bit of work that passes through his hands. Truly, this armature shop is out of the ordinary.

Remote Switch Control for Street Lamps.—From the *Elektrotechnische Zeitschrift* of recent date we learn that it is feasible and even permissible to increase momentarily the gas pressure in the pipe lines of illuminating gas systems. This principle has been actually used to light and to extinguish street lamps from the gas plant. On the same principle can be based a remote control of electric street lamps. It is only necessary to provide for certain groups of lights a switch box which contains a funnel-shaped casting, connected to the gas line and covered with an elastic membrane. An increased gas pressure will cause this membrane to bulge out, and this motion will operate a mercury tube contact, which in turn closes or opens the street-lighting circuit. A ratchet motion may be introduced between the membrane and the contactor to make the mechanism selective, so that half-night or full-night may be switched on and off at will. A gas-electric remote control system of this description is in successful operation at Nürnberg, Bavaria.

The Radio Patents Situation

AT this time when everyone seems to be interested in "radio," and when the market is being flooded with radio apparatus and there seems to be a real hysteria of production of both transmitting and receiving radio-phone apparatus, it seems to us proper to give a word of warning concerning the rights of patentees and the liability of infringers of patents. Hardly a day passes but what we hear of some litigation involving radio apparatus, and hardly a day passes but what we learn of some manufacturer who, perceiving a profitable field of endeavor, either drops what he is manufacturing and embarks upon the manufacture of radio apparatus, or adds the manufacture of such apparatus to his line. In most cases these manufacturers go blindly into this business, without taking into consideration the consequences which may result not only to themselves but to their customers, the retailers, who sell the apparatus which they manufacture, and to those who purchase such apparatus for their own use.

A cautious manufacturer and a good business man before investing the necessary capital to equip his plant for embarking upon the production of a new device—no matter what it may be—seeks the advice of competent patent counsel as to whether or not the thing which he proposes to manufacture and sell can be manufactured and sold by him without infringing an existing United States patent. He does not want to invest his money in machine designers and tools, jigs and other machinery, and in advertising propaganda, without knowing that such investment will be safe so far as his liability for infringement is concerned. He should know, and he desires to know, that he is not trespassing upon the rights of anyone else, and this is the proper and safe course which should be pursued by a cautious manufacturer. He seeks this counsel and advice concerning whether or not the thing which he proposes to manufacture and sell infringes an existing United States patent, even though he may have obtained a patent from the United States Government for his own device, for he knows that the grant of a patent does not confer upon a patentee the right to manufacture his own patented device, if it contains the invention of an existing prior patent, although the general belief is to the contrary.

A patent gives to the patentee or to the owner thereof the right only to exclude everyone else from making the patented invention, and it is in the exercise of such a right that the owner of a prior patent which is infringed by the subject-matter of a later patent demands of a Federal court that the manufacturer, seller or user of the subject-matter of the later patent shall be enjoined from the further manufacture, sale and use of the infringing article, and demands also the damages and profits to which he is entitled by reason of the infringement.

Many people believe that anyone has the right to manufacture for his own use a specimen of a patented device. This is not so. If such a right were given it is conceivable that a patent would be of no use whatever to the inventor, for the device may be an extremely simple one which can be readily manufactured by any person, and if all persons were free to manufacture one of these devices for their own use it would, as it can be readily perceived, render the patent absolutely worthless. Not only is one who manufactures and sells an infringing device responsible to the owner of a patent which may be infringed, but the retailer is also responsible, and ultimately the user, and the owner of a patent can sue anyone of them or all of them.

There are a great many patents relating to the radio art, both United States patents and foreign patents. Foreign patents, of course, cannot be infringed in the United States, but under certain conditions they may have a material bearing on the validity and scope of a United States patent. Expired United States patents are, as a rule, open and free to the public, but they also must be considered in determining the validity and scope of an existing United States patent.

When an applicant presents his application to the Patent Office the question to be determined is whether or not he is entitled to a patent for that which he shows, describes and claims in his application. In many cases the thing is made up of various mechanical elements; combinations and subcombinations of such elements being employed to produce an operative whole. The Patent Office causes a search to be made

through prior patents (those granted in foreign countries as well as those granted in the United States), and expired as well as existing patents. This search is made to determine whether or not the thing as a whole, or such combinations and sub-combinations thereof, as the applicant claims for his invention, is new; that is to say, whether it is shown in a prior patent. If found to be new and if its production constituted invention, a patent will be granted to the applicant.

The search which is made by the Patent Office is solely for the purpose of determining the novelty of the thing for which a patent is sought. The search which must be made to determine whether or not a thing which it is desired to manufacture and sell can be manufactured and sold without infringing an existing patent, is a vastly different search. It must not only cover all prior, existing and expired patents relating to the same art, but it must go into other arts. This is so because there may be included in the thing which it is desired to manufacture some particular device which has itself become recognized as constituting a distinct class of invention. For instance, a machine for sewing shoes which a manufacturer desires to put upon the market may embody in its construction a particular form of clutch. If so, the search to determine whether or not that machine may be manufactured and sold without infringing an existing patent must include all patents for sewing machines and also patents for clutches. In such a search it is necessary to consider the claims contained in existing patents, as well as what is shown in the drawings and described in the specifications, for it is the claims that determine the scope of a patent and what it covers.

In conducting a novelty search to determine whether or not the device is new and patentable, it is only necessary to consider what is disclosed in the drawings, the specification being referred to only for a better understanding of the drawings. Expired patents must also be considered in order to determine whether or not a claim in an existing patent supposed to be infringed has been anticipated by a prior patent, and also to determine what interpretation should be placed upon such a claim. The literature relating to the particular art must also be considered, for if a device has been described in a printed publication more than two years before the filing of an application upon which a patent has issued, it constitutes a complete anticipation of that patent.

As the Patent Office must grant a patent to one who produces a new and useful invention—no matter how many prior patents may be infringed thereby—it follows that it is not safe to assume, as many do, that the receipt of a patent from the United States Government gives the owner thereof the right to manufacture, use and sell devices embodying the invention of the patent. Much litigation results from the failure of manufacturers to know before they begin the manufacture and sale of a device, whether they have the right to do so, and the failure to observe the warning contained in the slogan, "Be sure you are right—then go ahead."

There are many United States patents for radio apparatus. They are in large measure extremely technical and obtuse. We venture to say that the average manufacturer who is now embarking upon the manufacture of such apparatus would not be able to understand such a patent if laid before him, and yet he takes a chance of great financial loss by going ahead.

With regard to one radio patent which has recently been before the courts, it has been decided that the inventor made a real invention, much broader than he or the one who prepared the patent was aware of, and as a consequence many devices are being manufactured and sold which will ultimately be found to be an infringement of that patent. Some manufacturers of radio apparatus know of that patent, and in a vague way they know what the courts have done in sustaining that patent. The patent covers a well-known so-called reamplifying receiving set. This is made up of various parts. It is surprising to learn how many believe that while they cannot make and sell the entire apparatus without infringing, they nevertheless have the right to make and sell the various parts of which it is made, and to sell such parts all ready to be assembled. The fact is, however, that one who makes and sells the parts of a patented apparatus, knowing that they are to be used for the production of that apparatus, is just as guilty of infringement as the one who makes and sells a complete assemblage of parts.

Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

Canada's Radio Fever.—From Toronto comes word that the radio fever has spread from the United States to Canada, and all the electrical firms and even other organizations not closely associated with electrical apparatus are experiencing an extraordinary inflation of trade. Factories are running under pressure, with three shifts every twenty-four hours, under conditions similar to those prevailing in munition works in the urgent days of the war.

China's Radio Link.—A system enabling telephone subscribers of Peking and Tientsin, China, to talk to each other by radio from their house or office telephones, the conversation taking place over wire lines to the central office and then by radio between the two cities—a distance of over 80 miles—was installed by the China Electric Company recently and tested successfully. The equipment is the product of an American company. It is believed that this is the longest radio telephone service open to public use in the world.

Radio Time Signal Indicator.—There has appeared in England a line of radio time signal indicators for use in shop windows and on outside walls so that the time signals may be flashed to a larger number of persons in the streets. One of the indicators takes the form of a miniature Eiffel Tower (for the signals are received from the Eiffel Tower in Paris) with an electric light at the top. As the radio time signals are received, an operator presses a key so that the light flashes in accordance with the intercepted signals. It is true that an appreciable loss of time takes place because of this relaying, but it is estimated that the interval of lost time is not greater than one-hundredth second. Another form is in the shape of a metal frame, with a glass face carrying the necessary lettering to indicate the elapsed minutes, such as "10-46," "10-47," and so on to the final dash at 11 o'clock. A system of lights controls the flashing of the proper minute reading, while a lamp on top of the frame and an electric bell are actuated when the final 11 o'clock dash is received.

The Elwell-Poulsen Arc.—The Imperial Wireless Telegraphy Committee of 1920 described the arc as "pre-eminent at the present moment among methods of long-range wireless transmission." Leafield, the first station of the Imperial chain, has now been equipped with the Elwell-Poulsen arcs similar to those at Lyons, Rome, Nantes, and so on. Transmitting press dispatches at low power preparatory to the opening of the similar station in Egypt, Leafield's signals were regularly received in Australia and India, and by British shipping throughout the routes to America, South Africa, and Australia. Arcs handle traffic with certainty and at low cost. They are particularly suited for use in districts remote from the great industrial centers. Arcs are recommended by the Wireless Telegraphy Committee of 1921 for installation in East Africa, Hong Kong, and Singapore.

British Empire's Radio Plans.—The original plan for a chain of medium-powered radio stations linking up the dominions with Great Britain has apparently undergone a radical change. As proposed by the Imperial Wireless Telegraphy Committee, it provided for stations of sufficient power to serve as relays in a system which would have formed a complete circuit around the globe, and each dominion would have financed the installation in its territory. From the outset, however, the idea failed to meet with the approval of the dominions, South Africa pleading lack of funds, India demanding direct service to England, and Canada and Australia indicating a desire to develop their own radio systems. Furthermore, reports seem to show that the first station in the chain erected at Leafield, Oxfordshire, has proved unsuitable because of the broad wave transmitted. The construction of the Cairo station has been delayed, and the announcement of the independent action of Australia indicates a definite abandonment of the general scheme so far as the dominions are concerned.

A Gentlemen's Agreement has been reached in the matter of radio-phone broadcasting activities in and about New York City. Heretofore the stations have operated more or less without reference to the activities of others, but from now on, according to a gentlemen's agreement arrived at among themselves and with the collaboration of the Radio Inspector, they are to arrange their programs so as not to interefere one with the other. Thus the most powerful station in regular operation, WJZ of Newark, N. J., operates the greater part of the evening. At 10:30, daylight-saving time, WJZ signs off for the evening, enabling smaller broadcasting stations to render their programs. During the day WJZ works every hour for 15 or 20 minutes, leaving the rest of the hour open for other stations. This system is doing much to reduce interference to a minimum, much to the satisfaction of the radio audience.

Department Stores and Radio.—From a report prepared by the National Retail Dry Goods Association, analyzing radio telephone conditions, we learn that there are at least seven department stores engaged in broadcasting, located as follows: Philadelphia, three; New York, one; Newark, one; St. Louis, one; Los Angeles, one. Numerous applications have been filed by other department stores, and the list is bound to be expanded materially by the time this is read. Department stores recognize radio as a merchandizing opportunity of the first order with an estimated annual volume of $70,000,000. In many of the larger stores sales of apparatus average $5,000 to $6,000 weekly in spite of the shortage of sets and parts. An important field is expected to be the rural general store, because radio telephony will bring metropolitan entertainments to country districts and assist in saving life and property in storms, flood or fire by sending out alarms and warnings.

Radio News Distribution.—From long and systematic experiments the German Post Office have come to the conclusion that radio telegraph is the simplest and cheapest means of distributing news from a central point. The Post Office administration have entered into an agreement with a news distributing agency for the circulation of market prices of stocks, prices of material, and so on. Subscribers to the service pay 4,000 marks per annum to the Post Office for installation and maintenance and a subscription for the news service to the Press Agency. Reception of news services which are not subscribed for is partially prevented by changing the figures which have to be decoded by the subscribers entitled to the particular service. The apparatus consists of a single-wire antenna, loop antennae not being used since they involve expensive amplifying receivers. A single tube receiver is supplied, supplemented where necessary by two audio-frequency amplifying tubes, while filament and plate currents are taken from the mains through suitable resistances.

Transatlantic Radio Transmission of Photographs.—Following in the footsteps of Edouard Belin, the French inventor who transmitted facsimile handwriting and cartoons across the Atlantic by radio over a year ago, comes the successful experiment of Dr. Arthur Korn of Berlin. Dr. Korn recently transmitted a photograph from Rome to Bar Harbor, Maine. According to the New York *World*, which assisted in this experiment just as it did in the Belin tests, Dr. Korn makes use of a code in transmitting photographs, instead of transmitting the photographic images themselves, as in the case of the Belin system. Dr. Korn's transmission is in the form of a coded message, which must be decoded or "translated" into a picture. First of all, the original photograph is reproduced in half-tone; that is to say, it is broken up into dots of various sizes, just as it is reproduced for printing purposes. The half-tone photographs is then placed in the coding machine which, by means of an optical system and a selenium cell, combined so as to classify the dots into seventeen or more sizes, assigns a given letter or word to each size of half-tone dot and prints the letter or dot on a paper tape. The letters and words on the paper tape are then transmitted by cable, telegraph or radio and received in the usual manner. The message is finally decoded by

means of a special typewriter which has the necessary arrangement of keyboard and handles a sheet 12 by 15 inches. The typewriter turns out an arrangement of large and small dots which constitutes the coarse photograph, and by reducing it to the desired size the image is sharpened accordingly.

Radio in Great Britain.—From Mr. W. H. Smith of the editorial staff of the *Illustrated London News*, we have received a most interesting letter in which he writes, in part: "Although the British daily papers have been booming radio day by day since the beginning of April, and the public has responded magnificently, there is at present very little to 'listen in' to. Every Sunday, 2-5 P. M., Dutch concert from the Hague, 1,070 meters. Every Sunday, about 3-4 P. M., Paris concert, consisting of songs and speech, 2,600 meters. Every Tuesday, 8-8:30 P. M., Marconi concert, 400 meters. Nearly every night, 9-9:30, unofficial broadcast test, consisting of four or five gramaphone records, transmitted by Burndept, of Blackheath, London, 400 meters. Being only four miles away, I get these very strong on one valve. Most evenings, 8-11 P. M., a few amateurs talking "tests" and sometimes an occasional gramaphone record. So far as the Dutch concert and Paris are concerned, these only just come in on one valve, and not at all on a crystal, so that the greater majority of wireless beginners, that is to say, those who have bought sets owing to the daily booming of the press, don't get much at present for their outlay, unless they happen to be rich and can afford the four-valve sets, costing fifty pounds or more. In the meantime, all of the wireless firms are flooded out with orders for receiving apparatus and parts, but, at the present moment, for some reason or other, they are hanging up their arrangements for broadcasting, which, unless something is done, and done quickly, will re-act on them. Naturally, once in possession of the means for getting the broadcasts, we want to know times and programmes, especially after business hours; otherwise one might listen all day and night to nothing but ships' Morse, and C.W. from the big stations. So, at the present moment, we are 'all dressed up, and nowhere to go.' However, a few gentle hints from the daily press are now being started, so things may buck up in the near future."

New Fire Regulations Pertaining to Radio.—Through its bulletin, "Safeguarding America Against Fire," the National Board of Fire Underwriters has made public the tentative regulations covering radio receiving installations, that disclose considerable modification as compared with the requirements previously issued. In brief, the tentative regulations applying to receiving installations only cover the following points: Antennae outside of buildings shall not cross over or under any electric light or power wires of any circuit carrying current of more than 600 volts. Antennae shall be constructed and installed in a strong and durable manner. Splices and joints in the antenna span, unless made with approved clamps or splicing devices, shall be soldered. Lead-in wires shall be of copper, approved copper-clad steel or other improved metal which will not corrode excessively, and in no case shall they be smaller than No. 14 B. & S. gage except that approved copper-clad steel not less than No. 17 B. & S. gage may be used. Keep lead-in wires away from power and electric light wires, by air spacing or by a continuous and firmly fixed non-conductor. Lead-in wires shall enter buildings through a non-combustible, non-absorptive insulating bushing. Each lead-in wire shall be provided with an approved protective device properly connected and located (inside or outside the building) as near as practicable to the point where the wire enters the building. The lead-in wire must not be placed near inflammable material. The use of an antenna grounding switch is desirable, but does not obviate the necessity for the approved protective device. The ground wire may be bare or insulated and shall be of copper or approved copper-clad steel. If of copper the ground wire shall be no smaller than No. 17 B. & S. gage. The ground wire shall be run in as straight a line as possible to a good permanent ground. Gas piping shall not be used for grounding protective devices. The ground wire must be protected against any possible injury. Wires inside buildings shall be securely fastened in a workman-like manner and shall not come nearer than two inches to any electric light or power wire unless separated therefrom by some continuous and firmly fixed non-conductor making a permanent separation.

Chemistry Notes

Results of Assays of Shale Oil are readily determined by means of an alinement chart recently published by the Bureau of Mines, and giving the relations between the weight and volume of shale and shale oil.

Tribute to Gas Mask Inventor.—E. F. Harrison, a well-known English chemist, entered the war as a private at the age of 47, but soon joined the anti-gas department and finally became Controller of Chemical Warfare. After many experiments he perfected the "box respirator." He died from the results of gas exposure. A memorial to him has been unveiled in the examination hall of the Pharmaceutical Society in London.

Gold-Bearing Whiskers.—Years ago an Illinois barber traded his razor for a pick and pan, and started for the Klondike. Unsuccessful in mining, he opened a shampoo parlor whose equipment included a cyanide tank. The cuttings from the hair and beard of the miners, he says, "assayed $100 the ton in the cyanide tank." The dollar apiece charged for shampoos and massages provided him with pocket money, but the suitcase full of gold which he brought back with him is all from the wealth-laden clippings that went through his cyanide bath, and he claims that this source has provided him with a fortune of a half-million dollars.

The Study of Helium Production.—That the Army and Navy are awake to the importance of non-inflammable balloon gas is seen in the transfer of $545,200 during the past fiscal year from the Army to the Bureau of Mines for helium work, while the Navy contributed $207,500 for the same purpose. The Bureau has appointed a board of engineers to study helium recovery at the Petrolia plant, which had to abandon large-scale operations because Congress refused the necessary appropriation. Of the above funds, $425,000 is available for the Petrolia investigations, the remainder being allocated among various laboratories devoted to cryogenic, helium storage, and repurification research.

Sulfur Dioxide Leaching.—Tests on the sulfur dioxide leaching of complex ores from the Miami district in Arizona have been completed at the Southwest station of the Bureau of Mines at Tucson. It is considered that sulfur dioxide leaching is a demonstrated success on the most refractory silicious ores in the Southwest and also on ores containing a large percentage of acid-soluble gangue. The commercial application of the process appears to hinge largely upon the successful working out of the manufacture of sponge iron. Laboratory work is being done on Walker-River silicious copper ore, which has soluble lime, iron, and manganese aggregating 10 per cent acid-soluble gangue. Results so far obtained are quite encouraging.

Underground Rivers of Brine.—A thousand feet beneath the town of Midland, Mich., run rivers of brine charged with calcium, sodium, magnesium, strontium, bromine and chlorine. Forty pumping wells raise the brine, and separative processes release from it the basis of photographic emulsions, medicines, cement, tanning materials, perfumes, preservatives and cold storage solutions. The magnesium was used for war flares, and now, combined in a secret alloy, furnishes metal one-third the weight of aluminum, sustaining a pressure of 24,000 pounds per square inch. In the form of gas-engine pistons, after a test equivalent to that of a motor car running 30 miles an hour continuously for 35,000 miles, scarcely a sign of wear was discernible.

"Credulochemistry."—Of all the "scientific" tidbits dished up by our newspaper chefs, none enjoys more perennial popularity than the discovery of the "lost art" of hardening copper. Only lately our foremost journals were devoting columns to the world-war veteran who, finding in an ashcan some leaves of an old encyclopedia dealing with an ancient metallurgist and his success in hardening copper, fell to experimenting on his own account, with the result that his process was bought by Judge Gary for a million in cash plus 2 cents per pound royalty. A modest and retiring denial subsequently appeared. For such newspaper cookery *Chemical and Metallurgical Engineering* suggests the apt name of credulochemistry, while the *Engineering and Mining Journal* intimates that the press might vary its menu by creating unbreakable glass for milk bottles and petrified wood for construction purposes. Certainly these would prove no less digestible than copper—even hardened copper.

CLASSIFIED ADVERTISEMENTS

Miscellaneous Notes

Our World Trade Cruise.—The "St. Louis," sailing from New York in January, carries the exhibits of 300 American manufacturers. The itinerary of this trade ship covers the chief ports of the world, including the West Indies, South America, Africa, Australia, Japan, China, the East Indies, India, Turkey, Greece, Italy, France, Spain, Portugal, Belgium, Germany, Holland, Sweden, Norway, and England and Scotland. It is a laudable attempt to familiarize foreign markets with American products.

Our World Trade Cruise.—There are some hard nuts to crack in laying out the exhibit space for a world trade cruise, in order properly to display the exhibits and still leave plenty of room for the perambulation of foreign buyers. Six decks of the "St. Louis" are given over to displays of machinery, textiles, foodstuffs, electrical equipment, automobiles, etc.; provision has been made for 200 passengers—salesmen, bankers' representatives, credit men, motion-picture operators, interpreters, and newspaper and magazine men.

Marketing Farm Timber.—To sell timber profitably owners of woodland must have a thorough knowledge of available markets. This knowledge may be acquired by learning the experience of neighbors, by applying to the State forester or the county agricultural agent, by employing the services of a man who knows market prices, and by getting into touch, by correspondence, with outside buyers, thus creating an open market. The Division of Publication, U. S. Department of Agriculture, Washington, furnishes free Farmers' Bulletin 1210, which contains much information on measuring and marketing farm timber.

Sweet Potatoes in Pictures.—On the way from farm to consumer, sweet potatoes deteriorate rapidly. Right methods of handling will do much toward reducing waste, and with this end in view the Department of Agriculture has prepared a motion picture entitled "Sweet Potatoes from Storehouse to Market." The bank or pit method means a loss of 50 to 75 per cent; cured in a good storehouse, unbruised in handling, and kept at the right temperature, the loss may run less than 5 per cent. The film shows a model storage house, the preliminary grading, the shipping in crates, and proper bracing in the refrigerator car.

The Scottish Boundary, over which the bloody tide of combat once ebbed and flowed, is still a desolate terrain with few inhabitants and fewer visitors. Mr. J. L. Mack of Edinburgh has recently explored the "Debatable Land" between Liddesdale and the Tweed. The Scots Dyke, five miles up the Sark, was constructed in 1552 to check the continual warfare at this point. Some years ago, woods on either side of the earthwork were leveled, resulting in the ruin of a third of the Dyke; Mr. Mack's efforts put a stop to this destruction. Eastward, the Old Toll Bar of the Bloody Bush is probably the only existing building of stone and lime now straddling the border. From Peel Fell westerly there is no habitation within two miles of the border for a distance of 35 miles.

Mail Robberies.—For the year immediately preceding April 8, 1921, the amount stolen from the mails was $6,346,407, with a recovery of $3,286,017. In April, 1921, action was taken by the Department by the promulgation of an order by the Postmaster General offering a reward of not more than $5000 for anyone who would bring in a mail robber, and the employes were armed with revolvers and shotguns. From that date until September 7, or five full months, the total amount stolen was $88,580, with a recovery of $78,555. This $88,580 includes an item of $33,000 non-negotiable paper, which a clerk attempted to burn. It will be noted that the approximate total loss for the 12 months preceding April 8, 1921, was $6,346,407, averaging a loss of $3,173,203.50 for each six months, as compared with the approximate loss of $88,580 for the last five months, a reduction of about 97 per cent; and that there was recovered during the 12 months preceding April 8, 1921, approximately $3,286,017, making an approximate recovery of 51 per cent of the total loss, while for the last five months $78,555 were recovered, making an approximate recovery of 88 per cent of the loss. It is the opinion of the Inspection Department that the arming of the employes and the offering of the reward has had much to do with the lessening of the robberies.

Psychology as a Business

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ket for his wares. An individual or a corporate client, actual or prospective, approaches this organization with the consciousness that he is dealing with a solid and responsible organization. It implies no reproach to the individual psychologist to point out that the client can hardly have the same confidence in his ability to handle all angles of one situation or of diverse situations that he can have in the ability of such an organization to distribute the phases of his problem to the appropriate members of its staff. It implies no reproach to point out that the guarantee of satisfactory work is more impressive coming from such a body as this than from any individual, whatever his standing.

For the present, the corporation is not going to bite off more than it can chew. Thanks to the army work and the subsequent experience with the Columbia entrance examinations, the general tests for intelligence, mental age, etc., are on a sufficiently definite basis to be given with confidence in their results. So are certain specific tests for specific abilities. It can be stated with absolute certainty, for instance, whether a person has sufficient musical ability to make it worth his while to attack the long and bitter preparation for a musical career. A test can be given to a group of candidates for clerical work which will without fail pick out the best clerks. Filing, stenography, and numerous other definite tasks or definite classes of work can similarly be made the subject of test. The mental age test now used in many schools could be made more general, under centralized supervision such as this corporation could give, and applied in other than educational fields. A very considerable number of persons might profitably avail themselves of the opportunity to take, privately, tests of the sort which are are now being incorporated into the Columbia entrance examinations, to determine whether the individual has a mind of the type that will derive benefit from college. Specific memory tests may be given to individuals or groups.

In all these fields, the psychologists feel that they have adequate correlations, and they are prepared to make any of the tests outlined, for individuals or upon groups for employers. As they establish new correlations they hope to extend their service to take in tests which today are not to be given with certainty, perhaps not even yet to be contemplated. Individuals seeking tests must of course go to the place where the member of the psychological staff qualified to make the test happens to be. To a large corporation, paying an adequate fee for a wholesale test of large groups of its employes or its applicants for employment, the psychologist must of course go himself.

The most confidence-inspiring feature of the new concern is the disposition which it plans to make of its profits. A certain amount of money is invested, and on this a return is to be paid. But this return is strictly limited to a reasonable per cent; and every penny that the corporation earns above this dividend requirement goes to the upbuilding of psychological research. This research, aimed to advance the cause of psychology, will necessarily, in most cases, be by or under the direction of members of the corporation: but this does not in the least afford freedom from the necessity of paying for it as it is done. The profits of the commercial end of the business, it is hoped, will be sufficient to put psychology in the same favorable position, as regards the support and the endowment of scientific advance, which physics, chemistry and allied sciences have for a decade or more been enjoying.

Submarine Telegraph Cables

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slightly moved a small mirror about half an inch in diameter attached to the moving coil, thereby reflecting a beam of light to the right and left representing the code. Even now the mirror galvanometers are useful for receiving messages on cableships. The modern receiving instrument is called a siphon-recorder because there is a delicate siphon of glass through which ink is spurted in tiny drops on to a moving strip of paper, by means of an electrical vibrating device. In this way the glass siphon is free to swing according to the positive and negative impulses received, without the end rubbing against the paper. A wavy line on a paper tape is then the means for reading the messages over long submarine cables.

Practically all cables in good condition are duplexed; that is, two messages are sent, one from each end, at the same time. To do this, very careful electrical adjustments, called balancing, must be maintained at all times. Quadruplexing of long submarine cables has not been satisfactory.

Radio communication is subject to interruption by atmospheric electrical storms and interference by other stations using the same wave lengths. Furthermore, all messages transmitted by radio can be read by all other stations. It is considerable trouble to code and decode all commercial messages. Commercial radio stations have been in operation for many years without noticeably taking business away from the cables and in fact new cables are being laid and projected; therefore it seems reasonable to expect that both systems will continue to be used, just as the telephone supplements, but does not replace, telegraph communication.

The submarine telegraph cables of the world number 530, with a total mileage of about 242,195; a sufficient length to encircle the earth at the equator about ten times. The longest section of submarine cable is part of the British Pacific cable between Vancouver and Fanning Island. This very long section has the remarkable record of uninterrupted service from natural causes since the original laying 19 years ago; except that during the recent war, the German cruiser "Nurnberg" cut this cable as an act of hostility.

Our National Military Policy

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have been due to an unbusinesslike organization of our national defense system and particularly to extemporized organization on the eve of an emergency. Our new law aims primarily to correct this defect. It provides for the systematic organization of our traditional citizen army in time of peace. We ask for no more professional officers and men than are required for specific military duties which in the nature of things cannot be performed by citizen soldiers.

The Unification of Communication Engineering

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have the phenomena of conduction, reflection, and radiation in varying relations depending upon the value of the frequency employed. In land-line telegraph practice, however, we find that after over half a century the signals are still sent by making and breaking a battery current. At each break the line is charged with a large number of idle harmonics which upset the line apparatus generally, and as no single frequency is used in sending the signals themselves, we are barred from utilizing the principles of electrical and mechanical tuning and of automatic magnification which have done such great things for the radio engineer. Since we can scarcely hope to realize in telegraphic practice Heaviside's "distortionless circuit," we can employ a "distortionless harmonic current" which, in the steady state, is propagated by any form of circuit with zero percentage change of shape and maximum efficiency of power transmission. As we pass immediately above ordinary telephonic frequencies on wires, we find a region of guided electric waves which are more or less linked with the conductor. It is not unreasonable to suppose that the telegraph engineer will in the future pay as much attention to the outside surface of his wires as he now does to the composition of the wires themselves. These surfaces may serve him to appropriate and control certain closely bounded regions of the free ether of space to create for him new channels of communication by guided electric waves. Our knowledge of skin effect should be extended by researches into the region bordering upon pure radiation, where we are dealing with a super-skin effect or film effect, and it seems not unlikely that we may be able ultimately to dip the wire or paint it with a metallic paint rich in unstable atoms or free electrons, which will tend to reduce the attenuation of the guided waves. Here the efforts of the master physicists should furnish a sure guide in the near future. These guided high-frequency channels are in some respects superior to any wire circuit. For telephony we may have in them a perfectly silent line, and one with no distortion whatever. The attenuation is greater, but it is not attenuation which limits wire telephony at present, but a mixture of line noises with distortion. With these new channels the telephone repeater comes into its own, since there is nothing to repeat but pure articu-

lation and quality. The telephone receiver itself may be of the radio type, 10 or 15 times more sensitive than those possible to use in wire telephony. In printing telegraphy these channels should also be useful as they can operate relays. They are free from many fluctuations or pure radio circuits, such as day and night differences, etc., and in a twisted pair become very reliable indeed. The new ionized-gas form of generator now furnishes a convenient high-frequency source in single or multiple units. The power required is negligible when compared with the case of free waves in three dimensions. The object of these remarks, therefore, is to offer a plea for a more general survey of telegraphy by engineers and physicists at this stage of rapid progress. At present we find the separation and segregation of the field of telegraphy into certain more or less watertight compartments under the head of wireless telegraphy, land-line telegraphy, ocean-cable telegraphy, etc., each of these possessing a separate technique. For instance, the radio engineer prefers to think in wavelengths, and he calls a variable inductance a "variometer," and a certain tuning coil a "jigger," etc., whereas, of course, there is nothing new in principle in these pieces of apparatus. The wire engineer prefers to think in terms of "frequency," and plots his graphs with n as a principle variable. The cable engineer thinks in terms of "curves of arrival." Has not the time arrived for the standing telegraph committees, wireless committees, cable committees, etc., of our scientific societies to combine in a membership that can look at this whole subject as one subject which in fact it appears to be?

Railway Engines With Steam Turbines

A SHORT while ago a new kind of railway engine driven by a steam turbine instead of the usual reciprocating cylinder and piston steam engine was tested on a trial run in Switzerland. This engine had been built on the design of Zoelly at the railway engine works at Winterthur. The results have been highly satisfactory, which, if one knew it from no other source, could be deducted from the fact that the wellknown Frederich Krupp company has bought the sole rights of manufacture of this new type of railway engine for Germany and other countries. In appearance this turbine engine is but little different to the piston engine. Two small turbines are built in beneath the boiler, one being for forward drive and one for driving in the opposite direction. The transmission of the driving power from the shaft goes via countershaft and gear and crank to the driving wheels. A very important advantage of the new railway engine as compared to the old is the fact that the steam turbines work with a very high vacuum in the condenser. Furthermore the condensed water is absolutely free from oil and fur-settling substances. For this reason it can be used over and over again for feeding the boiler. Owing to this advantage covering of the boiler pipes with fur or a coat of grease is completely avoided thereby ensuring greater economy in heating. Consumption of fuel is reduced and costs of cleaning boiler are saved. Another advantage of the new system is that the steam can be superheated to a greater degree than was the case with the old piston engines. This increases the thermic efficiency of the engine. In the usual types of superheated steam railway engines, as is well known, 350° is the highest degree of heat that can safely be used as otherwise the lubricating oils of the cylinders could not stand the heat which would result in the pistons and sliders seizing. The turbine engine needs to carry considerably less water on the tender than the ordinary on account of the condensed water being always used again and in spite of the cooling water required for the condenser. By means of an ingenious design the draught created by the running engine is used to cool sufficiently the warm water coming from the condenser.

The "Language" of Bees

PROFESSOR KARL VON FRISCH has recently published in the *Munich Medizin Wochenschrift* some observations upon the means of communication employed by bees. He placed a dish of sugar solution on a table by an open window. Shortly after a chance bee had noted this and flown off with booty therefrom, the dish was crowded with bees. When it was removed they quickly disappeared, save for an occasional reconnoiterer. When a fresh dish was set out they quickly reappeared in quantities. By touching the back of each bee with a spot of color, the experimenter then perceived that subsequent bees had been sent, and not escorted.

The conduct of the rediscoverer on her return to the hive was next noted. She first gave over her plunder to the workers, and then executed a curious dance, describing circles and other figures. Her audience watched her attentively and attempted to touch her. When one of the marked bees succeeded in this, the latter at once made her exit and flew to the feeding place; but the unmarked bees soon ceased to pay her any attention. It appears that there is here some means of communication based upon touch rather than upon sight or hearing; and that it is adequate for giving information as to the presence or absence of food, but inadequate to give its location unless she be already known to the recipient of the message.

Experiments with two dishes of food at a considerable distance apart verified this. As before, after they had once been discovered the dishes were removed and ultimately replaced; but when replaced, the "white" dish only was filled, the "yellow" one being left empty. The "white" dish was rediscovered by a "white" bee; and when the latter returned to the hive, not only the "white" but also the "yellow" bees responded to her dance, left the hive and flew to their respective dishes, the "yellow" bees of course having the search in vain. As before, unmarked bees ignore the dancer.

That there is a little more flexibility to the signal system than this might indicate appeared when natural conditions were imitated, linden and acacia blossoms being offered respectively to groups of bees accustomed to seek these. The dancing linden bee now occasioned excitement only among the linden bees, and not among the acacia group. The same distinction was made when two dishes of sugar were differently perfumed, suggesting that scent rather than actual modification of the signals may have been responsible. When blotting paper saturated with sugar-water was used instead of the dishes, the bees found some difficulty in sucking the fluid up, and returned only half laden. They did not then trouble to perform the dance, showing that this is reserved for exceptionally rich finds.

Some Problems of the Sea

A STUDY of the life in the sea is no longer one of scientific interest only, but one of pressing economic importance, as an added source of supply of human food for the ever-growing populations of the earth.

From a biological standpoint, are there any deserts in the sea? Is it possible to cultivate the sea as we do the land, or as we do our oyster resources, or our streams and lakes by stocking with fish?

To utilize our land areas economically, topographic, mineral, forest and other special surveys are essential. Just so, it is important to have a scientific survey of our ocean areas to enable us to take stock of its natural resources, and, having this, thereby to be in a position intelligently to develop and to utilize its resources in an economical and efficient manner.

Aside from being the highway of the commerce of the world, do we also need to use the food resources of the sea for the maintenance of the human race? Or, in other words, must we depend upon the sea to provide a portion of the food necessary for the existence of the coming populations? Does the human body now require for its best development any essential elements of food that can be supplied by the sea only?

If these questions are answered in the affirmative, then, among others, the sea food problem requires our most intelligent attention, especially as the people are even now taking thought of their food supply, which the tillable land areas of the earth are daily growing less and less able to meet, as evidenced by the rising basic costs of food. Sea foods have been looked upon as desirable, but not absolutely essential, parts of human diet. They may soon become necessary to supplement an inadequate food supply from the lands.

It was the belief of Sir John Murray that the sea is capable of a productivity equal to that of the land. It is generally estimated that less than five per cent of man's food now comes from the sea. If so, then the sea has unrealized possibilities of utilization that are vast from an economic standpoint, and a comprehensive study of these possibilities should not be overlooked or neglected, especially by maritime nations.

As the land areas are more subservient to the practical needs of man just so must the sea be made more useful in supplying the needs of the human race, both physical and

cultural. But the utilization of the resources of the ocean must and will follow its scientific investigation and study. It is essential, then, to find out what is in the sea, and then learn how to apply it to our needs.—Abstract from article in the *Journal of the Washington Academy of Sciences*, March 4, 1922.

Temperature Stimuli and the Life Cycle of Salmon

IN an interesting article presenting the results of the observation and study of the migration and spawning of Alaska red salmon (sockeye), published in *Economy* for October, 1921, Dr. H. B. Ward states that the factors which influenced the movements of salmon no doubt are numerous and that it would be wrong to seek a single influence or expect to find one which will determine all of the movements of the fish. Dr. Ward rejects the theory that the adults go back to certain points because they were born there. Rather, he finds that a fish reaches a certain point because it is acted upon by external factors. Where there is a choice of streams, some physical factor alone is definitely related to the choice of path. It appears that at the time the fish change their path, at the moment they come to a point demanding a choice, the stream which they choose is lower in temperature than the stream which they reject.

The generally accepted view that the sockeye always selects a stream with a lake is certainly true in the main. It is important to point out, however, that even when the lake is present, its relation to the spawning of the fish is rather variable. The fish may pass through two lakes and spawn in a third; they may pass through the first lake and spawn in a tributary stream on which there is another lake that they do not enter; they may spawn in a tributary without another lake; they may spawn in some part of the first lake reached. The evident variability of the relation between the lake and the spawning grounds of the sockeye seems sufficient to show, says the author, that such a water body is at most only indirectly essential when one considers the physical and climatic features in the regions in which salmon streams are located. The point is that streams having a lake will be usually cooler than those without one. In the short warm summer, streams flowing over rocks and stones and broken up by rapids and falls will be warmed rapidly by air and sun, and a large reserve volume in a lake will tend to keep the temperature lower on branches connected therewith than it is on those branches that are without lakes. The actual volume of flow, the length of the stream, and the exposure of its waters will in individual cases modify this general relation. The author concludes that so far as his operations have extended, the movements of the sockeye accord with the temperature relations, and that the lake is a somewhat variable associated factor. The selection in all cases tested seems to be determined by the relative temperature of the waters at stream junctions.

Low Pressure Chamber for Lung Operations

AN operation on the lungs presents serious difficulties, which have always given the surgeon considerable trouble. In order to get at the lungs the chest cavity must be opened and the ribs removed. This permits air to rush into the space surrounding the lungs. The air pressure within the organ is much less than that of the atmosphere, which results in utter collapse of the lungs. The patient cannot breathe under these conditions and unless precautions are taken to avoid this happening the operation cannot be performed.

A very ingenious arrangement has been introduced in the Munich Surgical Hospital in Germany, which makes it possible to conduct operations on the lungs without any danger of the patient stopping breathing. The operation is conducted in a chamber in which rarefication of the air by a few hundred millimeters is produced. Of course the maintenance of such a tenuity of the air is very difficult to accomplish in a large room. Hence this chamber is built as small as possible and is contained within a room of the hospital. It has no windows and the floor and walls are made as air tight as possible. A fan exhausts the air from the room continuously during the course of the operation. One end of the low pressure chamber connects with a small operating room through an opening at the height of the operating table. The opening is arranged in such a manner that when the patient lies on the operating table, his head projects out of the low pressure chamber. The connection is made air tight by the use of collars fixed around the neck of the patient. In this manner the patient can breathe properly and the narcotic can be administered by the doctor outside of the low pressure chamber. The operating surgeon remains within the low pressure chamber. He can converse with the attendants on the outside through special telephonic arrangements. There is also provided an entry chamber into which the operator enters first and in which the air pressure is then adjusted to that of the main chamber, before the door is closed.

Optimum Temperatures for Flower Seed Germination

IN the *Botanical Gazette* for December, 1921, Dr. G. T. Harrington, of the U. S. Department of Agriculture, presents interesting results of experiments made to determine the optimum temperatures for flower seed germination. Among the seeds tested were balsam, California poppy, cosmos, larkspur, marigold, mignonette, pansy, zinnia, candytuft, cypress, petunia, pink, poppy, portulaca and snapdragon. The facts ascertained by the author show that the use of warm temperatures usually increases the rapidity of germination of the species investigated, but that comparatively low temperatures are more favorable for completeness of germination. In conducting germination tests of each species, a temperature should be used which is warm enough to accelerate the progress of germination as much as can safely be done. At the same time it should not be warm enough to prevent the germination of any viable seeds, or to encourage more than is necessary the development of microorganisms.

When the germination temperature is too warm, frequently the germinated seeds make but little growth, and it is impossible to judge the comparative vigor of different lots of seeds. Sometimes weak seeds of little value will germinate when a warm temperature is used and will then appear to as good advantage as other strong vigorous seeds. If the germination tests are made with a more favorable temperature, both the strong and the weak seeds will germinate, but in this case the difference will be obvious at once. In this case, some seedlings make rapid, vigorous growth and are normal in appearance, while others have a watery translucent appearance, grow very slowly, and sometimes have begun to decay before emerging from the seed coat. On the other hand, too cool a temperature decreases the germination, increases the time required, increases also the difference in time required by different lots of seeds of the same species, and thus makes uniform procedure with the different lots impossible.

The Last of the "Mystery Towers"

WE have already published an account of the Shoreham "Mystery Towers," the huge concrete structures built by the British Admiralty for an unknown purpose during the European War. These monstrosities, after encumbering the waterway of the Solent for many months, are at last to be dismantled. The purpose of the towers, which has never been divulged, has been the subject of much controversy and surmise. Among the least fanciful of the conjectures were the use of the towers for raising sunken merchantmen, victims of the German submarine warfare; as gigantic caissons for the sinking of a channel tunnel between England and France; and as submarine forts to guard the approaches to the British naval base of Portsmouth.

Hickory Supply Ample

HICKORY is one of the best woods for automobile wheels and there is no danger of the exhaustion of hickory. So far as can be judged it will be one of the last woods of the country to fail to supply. Much is used for axe, hammer and similar tool handles and for vehicles, but it grows rapidly. It is peculiar among woods in that the faster it grows, the better it is. Second growth—which is a fast growing hickory—is preferred for wheel making purposes. The wide rings of spring wood which are found in open ground hickory trees give a strength and toughness, exactly what is desired by makers of vehicle wheels. It is believed that it will be a long time in the future before automobile makers cannot get wood for wheels if they want it.

Tire Competition — Good, Bad and Indifferent

THE average American was raised on the idea that the more people who competed for his trade the better off *he* was.

Like many good ideas, it has *several sides.*

They all show themselves clearly in the tire business.

* * *

There are tires which prefer to compete largely on a *price basis.* Believing that the public is more interested in the dollars and cents they pay than in the worth of what they get.

On the other hand, *U. S. Royal Cords* believe differently.

And car-owners who use Royal Cords have a *plus* feeling which they get both from actual experience, and because they realize the *integrity of the manufacturer.*

People don't think of Royal Cords as high-priced tires. They think of them as *better tires.*

In the man who knows what a *good, faithful product* the Royal Cord is, the tire that makes price its main argument hardly arouses more than a little curiosity.

* * *

So which is better?

A tire that thinks a man has no judgment beyond his pocket-book?

Or a tire like the U. S. Royal Cord—which credits the public with the instinct for *quality,* and the sense to find out *true economy?*

Prices on United States Passenger Car Tires and Tubes, effective May 8th, are not subject to war-tax, the war-tax having been included.

United States Tires are Good Tires

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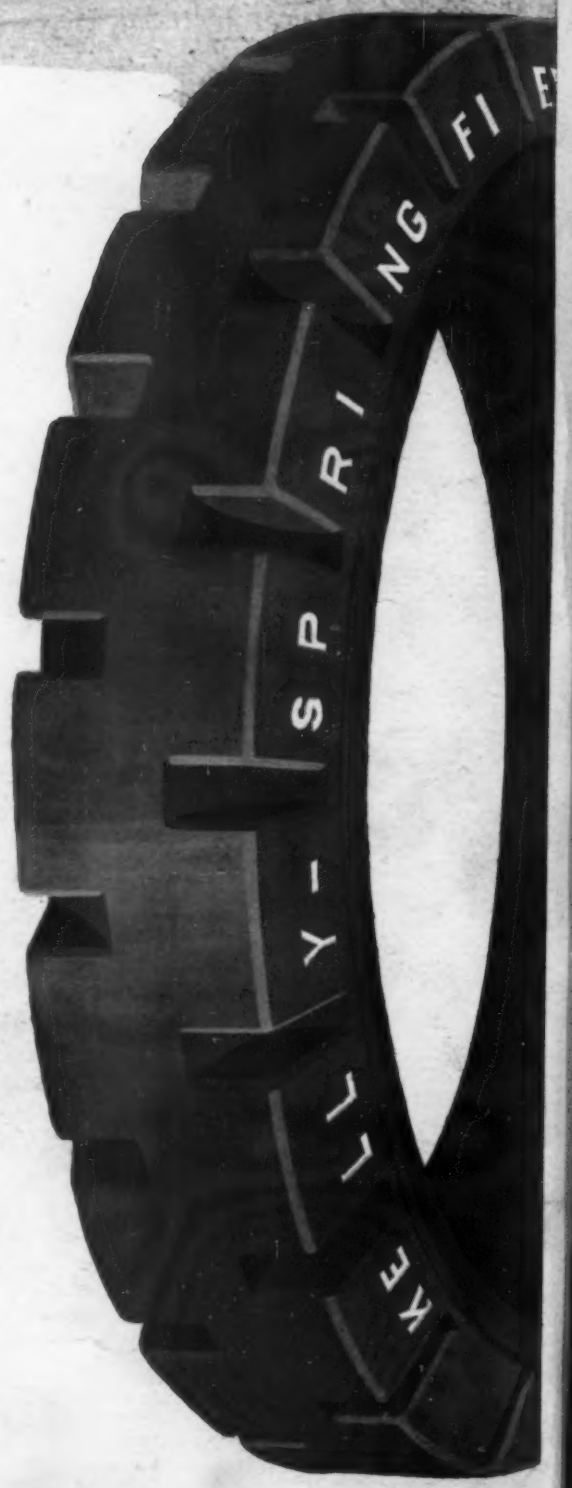

There's no other tire like the Caterpillar

No other tire can perform like the Caterpillar because no other tire has the Caterpillar's advantages. It gives traction without chains, easy riding qualities without punctures or blowouts and double the average mileage of any other type of tire.

Just what this extraordinary combination of qualities means to the truck owner is best told by one who has used Caterpillars on his own trucks and knows from experience what they will do. We quote below a letter from Mr. John C. Biddle of the Biddle Concrete Co., Clarksburg, W. Va., some of whose trucks are pictured above.

> "We are pleased to recommend the Kelly-Springfield Caterpillar tires. We have two of our trucks equipped with these tires at present and one of the trucks has been recently equipped with the second set.
>
> "We believe Caterpillar tires give us longer service, save wear and tear on our trucks and are much more economical than any other tires we have used."

If you would like to know more about a tire that can elicit such a strong testimonial as this we will gladly send you on request our little booklet "Caterpillar Logic," which explains in detail the particular usefulness of the Caterpillar in meeting the tire problems of various industries.

Caterpillars are made in sizes suitable for trucks of every type and weight

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